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Crab Spiders (Araneae: Philodromidae, Thomisidae) of Ramsey County, Minnesota

Daniel T. Jennings and Bruce Cutler

Cover photos courtesy of Lt. Col. Murray Cragin, USAF (retired).

Top left: Thomisidae, *Coriarachne versicolor*
Top right: Thomisidae, *Misumenoides*
Bottom left: Philodromidae, *Philodromus* sp.
Bottom right: Thomisidae, *Xysticus*

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Crab Spiders (Araneae: Philodromidae, Thomisidae) of Ramsey County, Minnesota

Daniel T. Jennings and Bruce Cutler

Crab spiders, families Philodromidae and Thomisidae, are among the dominant invertebrate predators found in many terrestrial communities. They inhabit vegetation and ground-litter strata where they forage for prey by active pursuit (Philodromidae) and by ambush (Thomisidae) (Comstock 1948, Gertsch 1979).

The philodromids have elongate legs of about equal length, except for species of *Ebo* which have the second pair of legs much longer than the first. The legs of philodromids have brushes of hairs that enable these spiders to run swiftly over precipitous surfaces (Gertsch 1979). Conversely, the thomisids have legs of unequal length; the first two pairs of legs are long and robust and are used to quickly embrace prey. The third and fourth pairs of thomisid legs are shorter and weaker than the first two pairs; hence, these spiders are relatively sedentary, but they excel as ambushers (Gertsch 1979). Crab spiders feed chiefly on insects, including pests of grasses, forbs, shrubs, and trees (Jennings 1974, Jennings and Toliver 1976).

Despite the common occurrence and potential economic importance of crab spiders, few studies have addressed the crab spider fauna found in particular communities or geographic areas (e.g., Cokendolpher *et al.* 1979, Sauer 1972). For the Great Lakes and Upper Midwest regions of the United States, crab spiders are included in the faunistic surveys by Chickering (1940), Drew (1967), Brady *et al.* (1991), and Snider (1991) in Michigan; by Levi and Field (1954) and Levi *et al.* (1958) in Wisconsin; by Cutler (1971, 1973), Cutler *et al.* (1975), Heimer *et al.* (1984), and Stratton *et al.* (1979) in Minnesota; by Leonard (1928) in New York; by Beatty (1988) in the Lake Erie islands, Ohio; and by Sauer (1972) in North Dakota. Only two of these studies (Chickering 1940, Sauer 1972) specifically and exclusively address the crab spiders (Araneae: Philodromidae, Thomisidae) found in these Northern States. For nearby Provinces of Canada, crab spiders have been studied in Manitoba (Aitchison-Benell and Dondale 1990), and in Quebec (Belanger and Hutchinson 1992); additional records for these and other Canadian Provinces have been summarized by Dondale and Redner (1978).

Crab spiders are of particular interest because some species have specific plant or habitat preferences. Such preferences may be useful indicators of habitat degradation or loss of habitat due to urban and suburban sprawl. Recent studies have shown that spiders are excellent candidates for bioassessment of changes in habitat quality (McIver *et al.* 1992).

During a 31-year period (1965-1995), we (mostly Bruce Cutler) collected crab spiders of the families Philodromidae and Thomisidae in Ramsey County, Minnesota. This paper summarizes these collections, provides identification sources, and presents information about the known biology of each collected species. The biological information includes season of maturation in Minnesota as well as recorded habitat associations in Minnesota and in other Northern States and Provinces.

MATERIALS AND METHODS

Study Area

We collected crab spiders in Ramsey County, Minnesota. This county is in southeastern Minnesota; it includes metropolitan St. Paul to the south and several suburban municipalities to the north. It is the most densely populated

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county of Minnesota and encompasses a land area of 419 km^2. An additional area of 35 km^2 is in water. The south edge of the county borders the Mississippi River, where steep bluffs occur. Elsewhere, the topography is flat to gently rolling, with many lakes.

The predominant soils are derived from glacial morainic deposits and gravel outwash plains, with sand intruding in the northern parts of the county (Schwartz 1936). The soils are classified as Central Wisconsin and Minnesota Thin Loess and Till, and Wisconsin and Minnesota Sandy Outwash (USDA 1981). Elevation ranges from 300 to 500 m; average annual precipitation is about 625 mm. Most of the precipitation falls during the growing season.

Wovcha *et al.* (1995) discuss the vegetation of Ramsey County incorporating numerous earlier sources. The original vegetation maps for Ramsey County are based on surveys by the General Land Office in the region from 1847-1857. The dominant vegetation was oak brushland and savanna. The brushland consisted of bur oak, *Quercus macrocarpa* Michx., and northern pin oak, *Q. ellipsoidalis* E. J. Hill, that formed a patchy canopy with the shrub layer. The shrub layer of the brushland was dominated by American hazelnut, *Corylus americana* Walt., raspberry, *Rubus strigosus* L., or chokecherry, *Prunus virginiana* L., and there were scattered prairie openings.

Oak savanna had the same oak species as the brushland, but the oaks were scattered or in groves. The savanna understory consisted of grasses, predominately large bluestem or turkeyfoot, *Andropogon gerardi* Vitman; little bluestem, *Schizachyrium scoparius* (Michx.) Nash; porcupine grass, *Stipa spartea* Trin.; and numerous prairie forbs. Forbs were more prevalent than shrubs in the oak savanna.

About 25 percent of the county was occupied by maple-basswood forest, i.e., the "Big Woods." Species of *Acer*, *Fraxinus*, *Quercus*, *Tilia*, and *Ulmus* comprised this maple-basswood forest. Both bur and northern pin oak were present; however, red oak (*Quercus rubra* L.) was more typical. *Tilia* and *Ulmus* formed a closed canopy. Oak forests also occurred as a result of canopy closure in the oak brushland.

Dry and wet openlands occupied about 10 percent of the county (Wovcha *et al.* 1995). Marshes, wet meadows, and fens formed most of this percentage, and were comprised of wetland sedges, grasses, and forbs. Dry prairie was dominated by the same grasses as found in the oak savanna. Floodplain forest (*Acer*, *Populus*, *Ulmus*) was found along the Mississippi River on the southern edge of the county. Less abundant vegetation types included a small area of conifer swamp with tamarack, *Larix laricina* (DuRoi) K. Koch, in the center of the county and elsewhere but in smaller scattered patches. Alder (*Alnus*), willow (*Salix*), and hardwood swamps were associated with margins of marshes in the county. Conifer forest was rare; however, there was at least one small grove of white pine, *Pinus strobus* L., near the Mississippi River (Butters 1936).

The original vegetation of Ramsey County has changed drastically in the last 150 years. The native trees are greatly reduced in number. For example, American elm, *Ulmus americana* L., has been decimated by the Dutch elm disease. The native prairie grasses are present only in relict form. Today, the most common xeric- and mesic-habitat grasses are introduced Old World species such as Kentucky bluegrass, *Poa pratensis* L., and smooth (or Hungarian) brome, *Bromus inermis* Leyss. In wet prairies and meadows, the introduced reed canary grass, *Phalaris arundinacea* L., has become even more predominant than the introduced drier-habitat grasses. Native forbs have fared better; for example, various species of asters (*Aster* spp.) and goldenrod (*Solidago* spp.) are now common in the county. The small tamarack swamp in the center of the county is gone; the only remaining occurrence of tamarack swamp is in the extreme northeast corner of the county. The white pine grove near the Mississippi River was cut some 60 years ago. Likewise, within the timespan of this study we have seen small remnants of habitat disappear due to ubanization. Based on surveys conducted by the Minnesota County Biological Survey between 1987-1990, only 1 percent of the original vegetation remains in the county.

Disturbed prairie or prairie-oak savanna as used in this paper refers to those areas surveyed that have some remnant of the native oak-savanna vegetation present. In addition to the bluestems, the indicator species are *Amorpha canescens* Pursh, *Asclepias tuberosa* L. and *Stipa spartea* Trin. For the most part, the plant names in this paper follow Ownbey and Morley (1991).

Other areas surveyed for crab spiders were mixed meadows; these were disturbed areas with introduced grasses, and introduced forbs, such as various species of Compositae, Cruciferae, and *Euphorbia*, and a good representation of native forbs. Such areas most likely had the original soil disturbed in the past, either by plowing or bulldozing. Old field refers to mixed meadow habitat with a definite shrub layer, such as native species of *Symphoricarpos, Ribes, Rosa,* and *Rhus*, and young trees, primarily *Quercus* and *Populus*. The oak-savanna remnants that are rigorously protected from fire, as almost all habitats surveyed are, have a different, intruding shrub layer consisting of *Corylus* and *Symphoricarpos*. Mesic woods refers to small forested areas with *Quercus, Acer, Populus, Tilia,* and *Fraxinus*. These undoubtedly represent patches of remnant maple-basswood forest. Ponds and streams are bordered by typical emergent vegetation such as *Scirpus, Typha,* and *Sagittaria*.

Two other minor habitats were sampled, i.e., small stands of conifers and sloughs or wet prairie areas. Today there are small stands of planted pines, in addition to numerous decorative plantings of conifers in house lots. These stands consist of jack pine, *Pinus banksiana* Lamb., red pine, *P. resinosa* Aiton, and white pine (*P. strobus* L.) in various combinations or singly. They support a spider fauna seen on native pines elsewhere in Minnesota. The sloughs, or wet prairie areas, occur commonly in the county; however, they lack the original diversity of vegetation (e.g., the orchid species) and have been extensively drained. Often they are dominated by *Phalaris arundinacea* L., rarely with *Spartina pectinata* Link., which was more abundant before farming took hold. *Asclepias incarnata* L. is an excellent indicator forb of such areas.

Collecting Methods

We used four basic methods for collecting spiders: (1) grasses, forbs, shrubs, and trees were swept with a heavy-duty beating net (30 cm diam. x 65 cm deep); (2) foliage of shrubs and trees were beaten either over a heavy-duty beating net or over a beating cloth (68 x 72 cm); (3) individual spiders were collected from specific plants or specific habitats, such as synanthropic habitats (i.e., habitats commonly associated with man (Kaston 1983)); and (4) pitfall traps (9 cm diam. x 9 cm deep; ca. 0.25-liter capacity; $n = 8$ traps) were deployed in select habitats to capture cursorial spiders. Ethylene glycol was added to each trap and trap contents were collected every 2 days for 2 weeks. For most study years, our primary collecting methods were sweeping and beating vegetation; we used pitfall traps only in selected habitats and for a brief 2-week trapping period in 1994.

Collected adult spiders were preserved in either 75 percent ethyl or 70 percent isopropyl alcohol. Collected immature spiders were provided *Drosophila* flies and other insects as food until the spiders reached maturity; once mature, the specimens were preserved for identification.

With few exceptions, only mature spiders were identified to species. The exceptions included penultimate males and females, usually collected with adult spiders, that showed characteristic coloration and other combined characters distinctive for the species. For example, penultimate males and females of *T. duttoni* have four pairs of spines on tibia I, but lack lateral stripes on the carapace margin. The only other species of *Tibellus* with four pairs of spines on tibia I is *T. chamberlini* Gertsch; however, this species has a pair of lateral stripes near the carapace margin. None of the latter species was collected.

Identifications were based chiefly on the keys and species descriptions of Philodromidae and Thomisidae by Dondale and Redner (1978), and their earlier cited works. We also consulted Turnbull *et al.* (1965) for determinations of *Xysticus* species.

The entire collection is deposited in the arachnid collections of the Department of Entomology, The American Museum of Natural History, New York.

Data Analysis

We used Sørensen's Similarity Quotient (QS) (Sørensen 1948), as modified by Price (1975), to compare the Ramsey County crab spider fauna, for both genera and species, with those from other faunistic studies in the Midwest and Great Lakes regions. This similarity index is based on the presence or absence of entities; the formula is $QS = 2C/(A + B)$, where A = the

number of genera or species in Ramsey County, B = the number of genera or species in the compared study, and C = the number of genera or species common to both. Price (1975) multiplied the resultant quotient by 100 to derive percentage similarity between compared faunas.

For such similarity calculations, recent synonymies of spider taxa (e.g., *Rhysodromus* = *Philodromus*) were taken into account. Nevertheless, the entity, *Corariarchne versicolor* X *C. utahensis* "hybrid" (see below), presented a problem, i.e., whether to count this entity as being in common with one or both parental species. Because the supposed "hybrid" may indeed be an undescribed species, we took a conservative approach and considered it not in common with either species. The Bray-Curtis or Wisconsin ordination index (Bray and Curtis 1957) was not used for these comparisons of faunal similarities because most of the collections (our study and others) were not quantitative samples.

RESULTS

Species Collected in Ramsey County

The species of Philodromidae and Thomisidae we collected in Ramsey County, Minnesota, are listed below. The order of listing follows that of Dondale and Redner (1978) and Turnbull *et al.* (1965). In most cases, species groups for *Philodromus* and *Xysticus* are indicated. Identification sources, season and collection frequency, and known biology are given for each species.

ARANEAE: PHILODROMIDAE

Genus *Philodromus* Walckenaer, 1826

aureolus Group

Philodromus cespitum (Walckenaer, 1802)

Identification.—The retrolateral tibial apophysis of the male palpus is truncate, while the ventral apophysis is two-pointed. Females are readily distinguished by a median depressed atrium at the anterior end of the epigynum, and the copulatory tubes are funnel-shaped (Dondale 1961, Dondale and Redner 1978).

Records.—Lauderdale: $n = 29$ collections; 22 males, 12 females. New Brighton: $n = 1$ collection; 1 male. Roseville: $n = 17$ collections; 10 males, 20 females. St. Paul: $n = 16$ collections; 11 males, 10 females.

Biology.—According to Dondale (1961), this species is biennial with two size-groups of immatures that overwinter. Conversely, Putman (1967b) reported that *P. cespiticolis* Walck. [= *P. cespitum* (Walck.)] appears to have an annual life cycle in the Niagara Peninsula, Ontario.

In Minnesota, penultimate males taken in February and penultimate males and females taken in March reached maturity in April in the laboratory. Likewise, individuals collected and reared in April and May matured in May and June, respectively. However, penultimate males were observed in the field in late June and July; penultimate females were observed in June and August.

Although adults of *P. cespitum* were collected each month in Minnesota from April to August, most were taken in June (45.3 percent) and in July (37.2 percent), where $n = 86$ total specimens. A penultimate male collected in July reached maturity in October; an immature female collected in August reached maturity in November. No doubt the favorable rearing conditions in the laboratory helped to advance development of these spiders.

In Minnesota, we collected *P. cespitum* most frequently by sweeping vegetation (grasses, forbs, and shrubs) of old fields and mixed meadows (31.8 percent of all collections, $n = 63$); less frequently by beating and sweeping foliage of trees (22.2 percent) and hand-collecting in synanthropic habitats (23.8 percent). The remaining collections of this species were from miscellaneous plants, including grasses, forbs, and shrubs (15.9 percent); on fences (3.2 percent); sweeping mesic woods (1.6 percent); and sweeping understory in *Pinus strobus* grove (1.6 percent). Fully 54.6 percent of all individuals collected ($n = 86$) were taken from herb-shrub strata.

Specific herb-shrub associations of *P. cespitum* in Ramsey County included: beating *Ribes* sp.; on leaf of *Phalaris arundinacea* L.; sweeping *Melilotus albus* Medic.; on leaf of *Asclepias*; on *Zea mays* L.; and on honeysuckle, *Lonicera* sp.

The arboreal habitat associations of *P. cespitum* in Minnesota included both deciduous and coniferous trees. At least three species of *Populus* yielded specimens: white poplar, *P. alba* L., eastern cottonwood, *P. deltoides* Marsh., and quaking aspen, *P. tremuloides* Michx. Other deciduous-tree habitats included foliage of Russian olive, *Elaeagnus angustifolia* L.; willow (in blossom), *Salix* sp.; and staghorn sumac, *Rhus typhina* L.

The coniferous-tree habitats of this philodromid in Minnesota included: jack pine, *Pinus banksiana* Lamb.; eastern white pine, *Pinus strobus* L.; and eastern redcedar, *Juniperus virginiana* L.

Our observed habitat associations for *P. cespitum* in Minnesota are similar to those previously reported in the literature. For example, *P. cespitum* has been found on tree and shrub foliage in coniferous and deciduous woods of Manitoba (Aitchison-Benell and Dondale 1990); on the shores of a marsh, lake, and large river; on herbaceous vegetation and under a leaf in Quebec (Belanger and Hutchinson 1992); on jack pine, *Pinus banksiana* Lamb., in Manitoba (Bradley and Hinks 1968); on eastern white pine, *Pinus strobus* L., in Wisconsin (Coppel and Smythe 1963); on cedars, *Thuja occidentalis* L., and junipers, *Juniperus communis* var. *depressa* Pursh, in Michigan (Drew 1967); and on balsam fir, *Abies balsamea* (L.) Mill., in New Brunswick (Loughton *et al.* 1963).

Deciduous-tree habitats for *P. cespitum* in northern regions include: on apple (*Malus pumila* Mill.) in Nova Scotia (Dondale 1956, 1958), in Quebec (Dondale *et al.* 1979), in Ontario (Hagley 1974), and in Wisconsin (Legner and Oatman 1964); and on peach trees in Ontario (Putman 1967a).

Previously recorded herb-shrub habitats for *P. cespitum* in northern regions include: on herbaceous vegetation and shrubs, Lake Erie islands, Ohio (Beatty 1988); on shrubs of upland hardwood forest and on vegetation of old fields and beaches in Michigan (Drew 1967); in sweepings of the herbaceous stratum of pine-black oak dunes in the Chicago area (Lowrie 1942, 1948); and in an overgrazed pasture in Ontario (Turnbull 1966).

Beatty (1988) also found *P. cespitum* on trees and buildings in the Lake Erie islands, Ohio.

Philodromus keyserlingi Marx, 1890

Identification.—The retrolateral apophysis of the male palpal tibia is short, and with two points nearly equal in size. The openings of the female epigynum are small and round (Dondale 1961, Dondale and Redner 1978).

Record.—Lauderdale: $n = 1$ collection; 1 male.

Biology.—Not much is known about the biology of this species. Dondale and Redner (1978) noted that *P. keyserlingi* has been collected by sweep nets in wooded areas of the Midwest and East, including Wisconsin and Michigan (*op. cit.*, Map 5). Our single collection of this species in Ramsey County was made 1 July 1980, "on fence in park."

Philodromus pernix Blackwall, 1846

Identification.—This species is recognized by the stout, hollowed projection at the base of the male embolus. The median septum of the female epigynum is short, with the anterior part occupying about one-half the length of the epigynum (Dondale 1961, Dondale and Redner 1978).

Records.—Lauderdale: $n = 4$ collections; 1 male, 3 females. Roseville: $n = 2$ collections; 1 male, 2 females. St. Paul: $n = 1$ collection; 1 female.

Biology.—This species overwinters in the penultimate instar under loose bark of trees (Kaston 1981). Lowrie (1942) noted that in such habitats *P. pernix* tends to aggregate in "pseudoflocks" of a dozen or more individuals during the winter months.

In Minnesota, a penultimate male collected in late May molted to maturity that same month; a penultimate female collected in January molted to maturity in March; and penultimate females collected in May matured in late May and early June. However, a penultimate female collected 5 November molted to maturity on 20 December; no doubt this advanced development was due to favorable laboratory-rearing conditions.

Although *P. pernix* has been recorded from a variety of habitats, we collected this species mostly from synanthropic (42.9 percent collections; 37.5 percent individuals) and tree (42.9

percent collections; 50.0 percent individuals) habitats. Specific-tree habitats were: on Scotch pine, *Pinus sylvestris* L.; beating *Pinus strobus* L.; and sweeping *Pinus*, 10 m tall (planted).

The coniferous-tree habitats for *P. pernix* in the Northern States and Canadian Provinces include: on coniferous foliage in Manitoba (Aitchison-Benell and Dondale 1990); on jack pine, *Pinus banksiana* Lamb., in Michigan (Allen *et al.* 1970) and in Manitoba (Bradley and Hinks (1968); on northern white-cedar, *Thuja occidentalis* L., trees in Michigan (Drew 1967); overwintering on pines, *Pinus* spp., in the Chicago area (Holmquist 1926); on foliage of balsam fir, *Abies balsamea* (L.) Mill., in east-central Maine (Jennings and Dimond 1988, Jennings *et al.* 1990) and in New Brunswick (Loughton *et al.* 1963); and on foliage of spruces, *Picea rubens* Sarg. and *Picea glauca* (Moench) Voss, in east-central Maine (Jennings and Dimond 1988).

Deciduous-tree habitats for *P. pernix* in northern regions include: on leaves of sugar maple, *Acer saccharum* Marsh., in Michigan (Uetz and Dillery 1969); and on leaves of shrubs and bark of trees in upland hardwood forest of Beaver Island, Michigan (Drew 1967).

Philodromus vulgaris (Hentz, 1847)

Identification.—Males of this species have a nearly truncate (sometimes pointed) retrolateral tibial apophysis, and one or two swellings at the base of the embolus. If two swellings are present, they are not at the same level. Females have deep longitudinal folds on the dorsal surfaces of the copulatory tubes (Dondale 1961, Dondale and Redner 1978).

Records.—Falcon Heights: n = 1 collection; 1 female. Lauderdale: n = 9 collections; 7 males, 2 females. New Brighton: n = 1 collection; 1 male. Roseville: n = 1 collection; 1 female. St. Paul: n = 7 collections; 5 males, 5 females.

Biology.—In Minnesota, this species overwinters as subadults; both penultimate males and females collected in early spring molted to maturity in April and May. Immature females collected in October and reared under laboratory conditions matured in November. Likewise, penultimate males collected in September molted to maturity later that month or in October. Adults of *P. vulgaris* were taken only in April (36.4 percent) and May (22.7 percent) in Minnesota, where n = 22 specimens.

Cokendolpher *et al.* (1979) summarized laboratory rearings of male and female *P. vulgaris* by month of molt; they concluded that this species reaches adulthood in early spring (March-April) in Texas.

This species occupies diverse habitats. In Minnesota, we found *P. vulgaris* most frequently associated with synanthropic (47.4 percent collections; 40.9 percent individuals) and tree (36.8 percent collections; 40.9 percent individuals) habitats; less frequently (15.8 percent collections; 18.2 percent individuals) on fences and in a spider's web. The tree habitats included both deciduous and coniferous trees. Subadults of *P. vulgaris* were found: on and under loose bark of eastern cottonwood, *Populus deltoides* Marsh.; beating foliage and under loose bark of bur oak, *Quercus macrocarpa* Michx.; and beating foliage of northern pin oak, *Q. ellipsoidalis* E. J. Hill. An immature female *P. vulgaris* was taken beating foliage of Scotch pine, *Pinus sylvestris* L.

On 29 October 1987 in Falcon Heights, an immature female *P. vulgaris* was found feeding on an immature theriidid spider, *Steatoda triangulosa* (Walck.), in the prey's web. The philodromid subsequently molted to maturity on 12 November 1987. On 7 September 1994 in Lauderdale, a penultimate male *P. vulgaris* was observed feeding on a female mosquito, *Aedes vexans* (Meigen), near a porchlight at 2200 h.

Other recorded habitats for *P. vulgaris* in northern regions include: on tree trunks and buildings, deciduous woods of Manitoba (Aitchison-Benell and Dondale 1990); in an orchard of Quebec (Belanger and Hutchinson 1992); on vegetation and buildings, and under rocks, Lake Erie islands, Ohio (Beatty 1988); on jack pine, *Pinus banksiana* Lamb., in Manitoba (Bradley and Hinks 1968); collected from trees and shrubs in Nova Scotia (Dondale 1961); in apple orchards of Ontario (Hagley 1974); and taken by beating net on ponderosa pine, *Pinus ponderosa* Laws., in North Dakota (Sauer 1972).

histrio Group

Philodromus histrio (Latreille, 1819)

Identification.—The male palpal tibia has one pointed retrolateral apophysis; the embolus is flat, curved or slightly angular. The angular spermatheca of the female distinguish this species from other members of the *histrio* group. This species also has distinctive markings on the abdomen and legs; the dorsum of the abdomen has a gray-green heartmark, followed by a series of yellow and gray chevrons; the legs have two longitudinal orange bands along their dorsal surface (Dondale and Redner 1975a, 1978). These markings allow easy recognition of immatures.

Records.—Arden Hills: $n = 1$ collection; 1 female. New Brighton: $n = 1$ collection; 1 female. Roseville: $n = 2$ collections; 2 females.

Biology.—In Minnesota, this species apparently matures in the early spring; adults were collected in late May and early June. We also collected and observed numerous juveniles in July and August of 1965, 1967, and 1973. Penultimate males ($n = 8$) and females ($n = 9$) were collected in September and October of 1967 and 1973. An immature female collected in late September 1995 reached maturity in late October that same year, under favorable rearing conditions. These data indicate that *P. histrio* overwinters in the penultimate instar and matures the following spring in Minnesota.

We collected *P. histrio* chiefly by sweeping grasses and forbs in old fields and mixed meadow, and by sweeping disturbed prairie. In Manitoba, Aitchison-Benell and Dondale (1990) noted that *P. histrio* was found on tree and shrub foliage of deciduous woods.

Our collections of *P. histrio* from old fields, mixed meadow, and disturbed prairie habitats in Minnesota are in keeping with the known habitat associations for this species. Dondale and Redner (1975a) noted that *P. histrio* is common on heather in Europe and on sagebrush in western North America. They further indicate that east of the Rocky Mountains this philodromid has been swept from heath plants near water, from weeds in abandoned fields, and from tall grass in prairies and meadows. Because of this species' close association with prairies and remnants of prairies, destruction and loss of prairie-habitat type may be critical for *P. histrio*.

imbecillus Group

Philodromus imbecillus Keyserling, 1880

Identification.—The base of the male embolus is concealed by the ventral apophysis of the palpal tibia. In females, the copulatory tubes have two coils and the spermatheca are well-separated (Dondale and Redner 1968, 1978). This species also has characteristic markings with longitudinal bands on the prolateral surface of the legs, and the dorsum of the abdomen has a brown or purple-brown heartmark followed by chevrons. The venter of the abdomen has a pale brown median band. However, the abdominal chevrons and ventral median band are absent in some females collected in Minnesota.

Records.—Arden Hills: $n = 2$ collections; 3 females. Lauderdale: $n = 4$ collections; 1 male, 4 females. Roseville: $n = 8$ collections; 16 males, 24 females. St. Paul: $n = 1$ collection, 1 female.

Biology.—In Minnesota, this species is mature in early summer; males were collected only in June; females were collected in May, June, and July. However, most (91.8 percent) adult specimens of *P. imbecillus* ($n = 49$) were taken in June.

In Minnesota, we collected *P. imbecillus* most frequently (93.3 percent collections; 91.8 percent individuals) by sweeping grasses and forbs in mixed meadows, old fields, and disturbed prairie. Dondale and Redner (1978) also noted that specimens of *P. imbecillus* have been collected by sweeping grasses and shrubs and by beating coniferous and deciduous trees in Canada. In Minnesota, none of our collections came from trees.

Other recorded habitat associations for *P. imbecillus* in the Northern States and Provinces include: on grass in meadows of Manitoba (Aitchison-Benell and Dondale 1990); on herbaceous vegetation, Lake Erie island, Ohio (Beatty 1988); on jack pine, *Pinus banksiana* Lamb., in Manitoba (Bradley and Hinks 1968); in an ombrotrophic bog; along a highway; and on conifers, shrubs, and grasses

in Quebec (Belanger and Hutchinson 1992); from vegetation of old fields, and from shrubs and herbs in mixed hardwood-conifer forest of Michigan (Drew 1967); on foliage of balsam fir, *Abies balsamea* (L.) Mill., in New Brunswick (Loughton *et al.* 1963); and from a pine-dune association in Illinois (Lowrie 1942, 1948).

rufus Group

Philodromus rufus vibrans Dondale, 1967

Identification.—Males of this species are recognized by the angular retrolateral tibial apophysis; females are recognized by the narrow septal web of the epigynum (Dondale and Redner 1968, 1978). The subspecies *vibrans* is distinguished from other subspecies of *P. rufus* by the yellow-brown carapace that is usually finely streaked in brown or black, and by the broad abdominal chevrons. However, in Minnesota, some females exhibit an intermediate coloration pattern between that of *P. rufus vibrans* and *P. rufus quartus* (Dondale and Redner 1968). In such specimens the chevrons are indistinct laterally; the legs and carapace have less speckling of brown and black.

Records.—Lauderdale: $n = 8$ collections; 3 males, 9 females. New Brighton: $n = 1$ collection; 1 male. Roseville: $n = 5$ collections; 2 males, 4 females. St. Paul: $n = 3$ collections; 3 females.

Biology.—The biology of the subspecies *vibrans* has not been studied *per se*; however, Dondale (1961) made an indepth study of the life history of *Philodromus rufus* Walckenaer collected from trees and shrubs in Nova Scotia. His material may have included *P. rufus vibrans*, which was not recognized as a subspecies until 1967 (Dondale 1967). Because two size-class groups were found in field samples, Dondale (1961) concluded that *P. rufus* is a biennial species.

In Minnesota, our collections of subadult *P. rufus vibrans* during early spring (March and April), followed by adults in May, June, and July, indicate that the subspecies *vibrans* overwinters as subadults and reaches maturity in early summer. These findings correspond with the early summer maturation of *P. rufus* observed by Dondale (1961) in Ontario. In Minnesota, adults of *P. rufus vibrans* were taken chiefly in May (31.8 percent) and June (27.3 percent), where $n = 22$ specimens. A penultimate male collected in late September, and reared in the laboratory, reached maturity in late October.

We collected *P. rufus vibrans* equally among synanthropic (23.5 percent collections; 18.2 percent individuals) and old field-mixed meadow (23.5 percent collections; 18.2 percent individuals) habitats, but more frequently on trees (27.3 percent collections; 50.0 percent individuals). The remaining specimens were taken on a fence, sweeping a lawn, and sweeping grasses and forbs in an oak-woodland. Specific tree habitats for *P. rufus vibrans* in Minnesota included beating collections from planted white spruce, *Picea glauca* (Moench) Voss; from planted white pine, *Pinus strobus* L.; from jack pine, *Pinus banksiana* Lamb.; and from northern pin oak, *Quercus ellipsoidalis* E. J. Hill. Additional tree habitats were: on the trunk of eastern cottonwood, *Populus deltoides* Marsh.; and sweeping planted white cedar in a suburban lot.

Dondale and Redner (1968) noted that *P. rufus vibrans* has been collected from *Thuja, Juniperus, Pinus, Picea, Abies*, and many species of deciduous trees and shrubs. They also noted that this species and subspecies is sometimes found in or on buildings. Kaston (1983) included *P. rufus* Walckenaer among the synanthropic spiders not commonly found in houses. Our collections of *P. rufus vibrans* from domestic habitats in Minnesota indicate that the subspecies *vibrans* also is sometimes synanthropic.

The recorded habitat associations for *P. rufus* are numerous; those specifically for *P. rufus vibrans* include: in trees in Quebec (Belanger and Hutchinson 1992); from a mown meadow near Belleville, Ontario (Dondale 1971); on black walnut, *Juglans nigra* L., in southern Illinois (Jennings 1976); and on foliage of balsam fir, *Abies balsamea* (L.) Mill., in east-central Maine (Jennings and Dimond 1988).

Philodromus placidus Banks, 1892

Identification.—This species is easily recognized by the black bands on legs III and IV, and the bidentate retrolateral apophysis of the male palpal tibia. In females, the spermathecae resemble those of *P. peninsulanus* Gertsch, but can be distinguished by their globular, uncoiled structure (Dondale and Redner 1968, 1978).

Records.—Lauderdale: n = 8 collections; 4 males, 4 females. Roseville: n = 3 collections; 1 male, 2 females. St. Paul: n = 1 collection; 2 males.

Biology.—In Minnesota, adults of this species were found in midsummer from June to August. Apparently the species overwinters as subadults; a penultimate male and female taken in April reached maturity in May and June, respectively. An immature female collected in early July matured in mid-July. However, 61.5 percent of all specimens (n = 13) were taken in June.

Although Dondale and Redner (1978) concluded that the main habitat for *P. placidus* is the foliage of conifers, most of our specimens of *P. placidus* were taken by sweeping herbaceous vegetation in grassy meadows (41.7 percent collections; 38.5 percent individuals). Only three specimens of this species were collected by beating coniferous-tree foliage in Minnesota: a male and female from white spruce and a female from white pine. Other habitats included: on a *Solidago* stem, eating immature hemipteran; sweeping *Rubus occidentalis* L.; on a lawn; and on a wooden fence in mesic woods.

Jennings and Collins (1987b) summarized the known coniferous-habitat associations of *P. placidus*, which included species of *Abies*, *Juniperus*, *Picea*, and *Pinus*. Heimer *et al.* (1984) noted that *P. placidus* was taken on red pine, *Pinus resionsa* Aiton, in Itasca State Park (Clearwater and Hubbard Counties) of Minnesota. Our collections from foliage of *Picea glauca* (Moench) Voss and *Pinus strobus* L. in Ramsey County, Minnesota, provide new information about the distribution and habitat associations of this philodromid spider.

Additional coniferous-tree habitats of *P. placidus* in the Northern States and Provinces include: on coniferous foliage in coniferous woods of Manitoba (Aitchison-Benell and Dondale 1990); on spruce (*Picea* sp.) in Quebec (Belanger and Hutchinson 1992); on foliage of balsam fir, *Abies balsamea* (L.) Mill., red spruce, *Picea rubens* Sarg., and white spruce, *Picea glauca* (Moench) Voss, in east-central Maine (Jennings and Dimond 1988); on balsam fir, *Abies balsamea* (L.) Mill., and red spruce, *Picea rubens* Sarg., in east-central Maine (Jennings *et al.* 1990); in Malaise traps in spruce-fir forests of west-central Maine (Jennings and Hilburn 1988); and captured in pitfall traps deployed in strip-clearcut and dense spruce-fir forests of Maine (Jennings *et al.* 1988).

Other recorded habitats for *P. placidus* include: on herbaceous vegetation, shrubs, and trees, Lake Erie islands, Ohio (Beatty 1988); in minerotrophic and ombrotrophic bogs, in alpine tundra, and on shrubs in Quebec (Belanger and Hutchinson 1992); from apple, *Malus pumila* Mill., trees in Nova Scotia (Dondale 1956) and in Quebec (Dondale *et al.* 1979); from trees and shrubs in Nova Scotia (Dondale 1961); and from alfalfa communities in New York (Pimentel and Wheeler 1973, Wheeler 1973).

Genus *Tibellus* Simon, 1875

Tibellus maritimus (Menge, 1875)

Identification.—Males of *T. maritimus* have an enlarged, grooved embolus, and lack an apophysis on the palpal tibia. The copulatory openings of females are near the center of the epigynum; the spermathecae are relatively slender (Dondale and Redner 1978).

Records.—Lauderdale: n = 3 collections; 1 male, 2 females. New Brighton: n = 1 collection; 1 male. Roseville: n = 7 collections; 19 males, 10 females.

Biology.—In Minnesota, this species reaches adulthood in early summer. Adult males and females were collected in May, June, and July; most frequently in June (81.8 percent), where n = 33 specimens. A penultimate male collected in late September, and reared under laboratory conditions, reached maturity in late October.

All of our collections of *T. maritimus* were made by sweeping grasses and forbs in old field, old field-woods edge, mixed meadow, prairie, and field oak-woodland habitats.

Cutler (1971) collected this species from heading bluegrass, *Poa pratensis* L., in Roseau County, Minnesota. Later, Cutler *et al.* (1975) reported that *T. maritimus* was taken in pitfall traps set in *Populus tremuloides* Michx. stands of north-central Minnesota.

In Canada, Dondale and Redner (1978) noted that the habitat of *T. maritimus* is tall grass. Other recorded habitats for this spider include: on tall grass in fields, sloughs, lake shores, and mixed prairie of Manitoba (Aitchison-Benell and Dondale 1990); on vegetation, Lake Erie island, Ohio (Beatty 1988); on the shore of a lake, gravel pit, and in shrubs and grasses of Quebec (Belanger and Hutchinson 1992); from grassy borders of wheat fields in Saskatchewan (Doane and Dondale 1979); from roadside vegetation and juniper bushes in Michigan (Drew 1967); swept from the herbaceous stratum of a peat meadow, Dune Acres, Indiana (Lowrie 1942); and from a black oak, *Quercus velutina* Lam., dune association in Indiana and Illinois (Lowrie 1948).

Tibellus oblongus (Walckenaer, 1802)

Identification.—The male embolus is slender and fully exposed; the palpal tibia has a fingerlike retrolateral apophysis. The copulatory openings of the female are near the posterior margin of the epigynum, which has convex lateral margins (Dondale and Redner 1978).

Records.—Arden Hills: $n = 2$ collections; 3 males, 4 females. Lauderdale: $n = 19$ collections; 14 males, 21 females. New Brighton: $n = 3$ collections; 6 females. Roseville: $n = 15$ collections; 28 males, 35 females. St. Paul: $n = 2$ collections; 1 male, 5 females.

Biology.—This species matures in late May, June, and July in Minnesota. Although a few penultimate males and females of *T. oblongus* were collected in both June and July, most of the specimens taken during these months were adults. Of the 117 adults collected, 41.0 percent were taken in June and 45.3 percent were taken in July. The remainder were collected in May (0.8 percent), August (4.3 percent), and September (8.6 percent). Only females were taken during these latter months; a mature female was taken as late as 29 September. Combining collections from all years indicated that the sexes were about equally represented in both June (21 males, 27 females) and July (24 males, 29 females). Four females were taken with egg sacs from 10 July to 28 July of 4 separate years; in addition, one female spun an egg sac shortly after capture in July 1968. These findings agree with those of Kaston (1981), who noted that in Connecticut the eggs of *T. oblongus* are laid in June and July, and the young emerge in August and September.

In Minnesota, we collected *T. oblongus* ($n = 41$ collections; $n = 117$ individuals) most frequently (80.5 percent collections; 91.4 percent individuals) by sweeping grasses and other herbaceous vegetation in old field, mixed meadow, field-oak woodland, and disturbed prairie habitats. Additional specimens were taken in sedges, on *Phalaris arundinacea* L., sweeping *Typha* sp., sweeping *Bromus inermis* Leyss., and sweeping corn, *Zea mays* L. Heimer *et al.* (1984) noted that *T. oblongus* was taken from grassland in Itasca State Park (Clearwater and Hubbard Counties) of northern Minnesota.

The recorded habitats for *T. oblongus* in other Northern States and Provinces include: on tall grass of deciduous woods, meadows, fields, bogs, and mixed prairie of Manitoba (Aitchison-Benell and Dondale 1990); on jack pine, *Pinus banksiana* Lamb., in Michigan (Allen *et al.* 1970); on tall herbaceous vegetation in fields, on buildings, Lake Erie islands, Ohio (Beatty 1988); from a grassy hill, along a highway, mixed forests and their borders, grassy glade; on grasses and club-rush (*Scirpus* sp.), rushes (*Juncus* sp.), and flowering plants in Quebec (Belanger and Hutchinson 1992); dislodged from apple, *Malus pumila* Mill., trees in Nova Scotia (Dondale 1956); from shrubs of upland hardwood and mixed hardwood-conifer forests, on junipers, and sweeping vegetation of old fields in Michigan (Drew 1967); in Malaise traps in spruce-fir forests of west-central Maine (Jennings and Hilburn 1988); captured in pitfall traps deployed in strip-clearcut and dense spruce-fir forests of Maine (Jennings *et al.* 1988); from shrubs and trees in Ontario (Kurata 1941); from fields and roadsides in Wisconsin (Levi and Field 1954); swept from the herbaceous stratum of pine, black oak, peat meadow communities in the Chicago area (Lowrie 1942); from black oak, *Quercus velutina* Lam., dunes in Illinois and Indiana (Lowrie 1948); from an alfalfa community in New York (Pimentel and Wheeler 1973); and in pitfall traps deployed in mixed conifer-hardwood stands of New Brunswick (Varty and Carter 1974).

Young and Edwards (1990) summarized the numerous habitat associations of *T. oblongus* with field-crop monocultures in the United States.

Tibellus duttoni (Hentz, 1847)

Identification.—This species and *T. chamberlini* Gertsch each have four pairs of ventral macrosetae on tibia I; however, *T. duttoni* lacks lateral stripes on the carapace margins. In *T. duttoni*, the male embolus is slender and lacks a distinctly notched margin. The spermathecal organ of female *T. duttoni* does not extend to the anterior margin of the spermatheca; it extends only two-thirds or less (Dondale and Redner 1978).

Records.—Roseville: $n = 9$ collections; 25 males, 12 females.

Biology.—This species matures in early summer in Minnesota. Adults ($n = 37$) were collected in May, June, and August; however, most (86.5 percent) were taken in June. Unlike *T. oblongus*, the sexes of *T. duttoni* were unequally distributed among the June collections (23 males, 9 females) and over all collections (27 males, 10 females). We are unable to explain these discrepancies in sex ratio; perhaps females of *T. duttoni* are more sedentary and less apt to be dislodged by sweeping than the males. Penultimate females (recognized by spination on tibia I) of *T. duttoni* were collected in May ($n = 3$) and June ($n = 2$); a single penultimate male was taken in September.

In Connecticut, Kaston (1981) noted that the sexes of *T. duttoni* mature in early May and females have been taken through August.

We found this species only at three sites in Ramsey County, all in Roseville. Two of these sites had old field vegetation, i.e., a mixture of grasses and forbs. All but one male specimen was swept from such vegetation (88.9 percent collections; 97.3 percent individuals); the single male came from a suburban lawn near one of the old field sites. Dondale and Redner (1978) noted that the habitat of *T. duttoni* is tall grass.

Kaston (1981) noted that *T. duttoni* is more common in the Southern States than in the north. Gertsch (1933, p. 12) stated that "*Tibellus duttoni* (Hentz) is found in the southeastern part of the United States..., while in its northern range it has been taken in the Mississippi Valley to Minnesota and Michigan and on the east coast in New York and neighboring states."

Few habitats have been recorded for this species in the Northern States and Provinces; most habitat-association records for *T. duttoni* concern Southern States. In Manitoba, Aitchison-Benell and Dondale (1990) noted that *T. duttoni* was found on tall grass in bogs. However, Kurata (1941) reported that *T. duttoni* was found on shrubs and trees in Ontario.

Young and Edwards (1990) summarized the habitat associations of *T. duttoni* with various monocultures, which included peanuts in Texas and cotton in Arkansas and Texas.

Genus *Thanatus* C. L. Koch, 1837

Thanatus striatus C. L. Koch, 1845

Identification.—Males of this small *Thanatus* have a short, slightly curved embolus; females have slender spermathecae which are well-separated and each with one transverse groove (Dondale *et al.* 1964, Dondale and Redner 1978).

Records.—Lauderdale: $n = 2$ collections; 1 male, 1 female.

Biology.—Little is known about the biology of this species; apparently, it reaches maturity in early summer in Minnesota. A single female was collected in May, and a male was collected in June. In Connecticut, Kaston (1981) indicated that *T. striatus* apparently overwinters in the penultimate instar, and is mature in May and June.

In Minnesota, this species was collected by sweeping mixed meadow, and on the arm of Matt Cutler. Apparently, the latter specimen fell from a tree.

The recorded habitats of *T. striatus* in northern regions include: in ground litter of meadows, sloughs, and deciduous woods of Manitoba (Aitchison-Benell and Dondale 1990); from a beaver pond, cultivated field, and gravel pit in Quebec (Belanger and Hutchinson 1992); from grassland litter, and occasional specimens taken by sweep nets in low vegetation in Canada (Dondale and Redner 1978); from grassy borders of a wheat field in Saskatchewan (Doane and Dondale 1979); from hayfields and their margins in Nova Scotia (Fox and Dondale 1972); and swept from the herbaceous stratum of the Jackson Hole region of Wyoming (Lowrie 1968).

In Connecticut, Kaston (1981) noted that *T. striatus* was not very common, but had been found in marshy places, sandhills, and dunes, and by sifting debris brought down by spring floods.

T. striatus also has been taken from the herb-shrub stratum of cotton fields in Alabama (Young and Edwards 1990).

Thanatus formicinus (Clerck, 1757)

Identification.—Males of *T. formicinus* have an elongate, slender retrolateral apophysis on the palpal tibia that points distad. They also lack the swelling on the tegulum that is present in *T. coloradensis* Keyserling. Females of *T. formicinus* have wide, angular spermathecae that are sparsely grooved (Dondale *et al.* 1964, Dondale and Redner 1978).

Records.—Lauderdale: $n = 3$ collections; 2 males, 1 female. New Brighton: $n = 1$ collection; 1 male. Roseville: $n = 1$ collection; 1 female. St. Paul: $n = 1$ collection; 1 male.

Biology.—In Minnesota, adults of this species were found in late spring and early summer. Males were collected in April and May; females were collected only in June. Kaston (1981) indicated that *T. formicinus* spends the winter either in the adult or penultimate instars; mature males have been collected in April and May, and females have been collected from March to July and in November in Connecticut. In Minnesota, a penultimate male taken in late September reached maturity in early December under laboratory rearing conditions.

We collected females of *T. formicinus* in Minnesota by sweeping grasses and forbs in mixed meadow; we found males running on ground in mixed meadow, running on ground in badly disturbed meadow, and on stone on gravelly ground.

This species occupies numerous habitats; apparently it is found in more diverse habitats than *T. striatus*. Dondale *et al.* (1964) reported that the habitats for *T. formicinus* include: in pine, fir, or aspen forests up to elevations of 2920 m in Colorado; under ground debris on a lakeshore in Utah; on a beach in Long Island, New York; and in grass, low shrubs, and in pitfall traps in Nova Scotia and Ontario. Additional recorded habitats for this species in northern regions include: in ground litter of coniferous and deciduous woods, fields of Manitoba (Aitchison-Benell and Dondale 1990); in a forest clearing of Quebec (Belanger and Hutchinson 1992); in a wheat field of central Saskatchewan (Doane and Dondale 1979); on apple, *Malus pumila* Mill., in Nova Scotia (Dondale 1956); from a mown meadow in Ontario (Dondale 1971); from vegetation of old fields, grassy openings in mixed hardwood-conifer forest, and on clumps of beach grass in Michigan (Drew 1967); from hayfields and their margins in Nova Scotia (Fox and Dondale 1972); swept from grass and bushes and from tree trunks in Connecticut (Kaston 1981); in grass in Wisconsin (Levi and Field 1954); and from crowns of red pine, *Pinus resinosa* Aiton, in Ontario (Martin 1966).

ARANEAE: THOMISIDAE

Genus *Tmarus* Simon, 1875

Tmarus angulatus (Walckenaer, 1837)

Identification.—The embolus of the male palpus is without a terminal hook; it ends in a slightly curved tip. The female epigynum lacks a pronounced median septum as in *T. rubromaculatus* Keyserling (Gertsch 1939, Dondale and Redner 1978).

Records.—Lauderdale: $n = 2$ collections; 1 male, 1 female. St. Paul: $n = 1$ collection; 1 male.

Biology.—Both Jones (1940) and Peck (1966) gave notes on the life history of *T. angulatus* in Illinois and Missouri, respectively. In Minnesota, this species apparently reaches adulthood in late spring to early summer. Males were collected in May and June; a single female was collected in June. Gertsch (1939) reported the capture of a male *T. angulatus* in June from Minneapolis. This species apparently matures earlier in the South; Peck (1966) noted that adults were found only in April in Missouri. Jones (1940) indicated that *T. angulatus* matures in late spring or summer in Illinois.

This interesting species is usually found in shrub-small tree habitats. In Minnesota, we collected *T. angulatus* by beating *Rhus typhina* L. and by beating *Salix* sp. in bloom. One adult male was taken on a fence.

Dondale and Redner (1978) noted that specimens of *T. angulatus* have been collected by beating trays from the twigs of various trees and shrubs. Our collections of *T. angulatus* from staghorn sumac and from willow in Ramsey County complement such habitat associations. In Missouri, Peck (1966) noted that this species was not collected in surface litter or in pitfall traps, but that it was collected exclusively in shrub strata of forest habitats.

Other recorded habitat associations for *T. angulatus* in northern regions include: on tree branches, deciduous woods and tamarack woods, of Manitoba (Aitchison-Benell and Dondale 1990); from a streamside, field, and planting of willow (*Salix* sp.); in pines (*Pinus* sp.), oaks (*Quercus* sp.), poplar (*Populus* sp.), and apple (*Malus* sp.); from shrubs and grasses in Quebec (Belanger and Hutchinson 1992); in forest-floor litter of a beech-maple forest in Ohio (Bultman and Uetz 1982); beaten from foliage of apple (*Malus pumila* Mill.) trees in Nova Scotia (Dondale 1956) and in Quebec (Dondale *et al.* 1979); in a beech-maple forest of Indiana (Elliott 1930); from an old field, Itasca State Park, in Minnesota (Heimer *et al.* 1984); in herbs and shrubs of an elm-maple forest in Illinois (Jones 1940, 1946); in high grass in Wisconsin (Levi and Field 1954); swept from the herbaceous stratum of a mesic-pine swale in the Chicago area (Lowrie 1942); from subclimax and climax beech-maple forests in Michigan and Indiana (Lowrie 1948); collected by sweeping shrubs in North Dakota (Sauer 1972); and on foliage of Douglas-fir (*Pseudotsuga menziesii* (Mirbel) Franco) in British Columbia (Turnbull 1956).

Although *T. angulatus* is usually found in shrub-small tree habitats, it also has been collected from field-crop monocultures including peanuts in Texas and alfalfa in New York and Virginia (Young and Edwards 1990). Pimentel and Wheeler (1973) also recorded this species from an alfalfa community in New York.

Genus *Misumenoides* F. O. Pickard-Cambridge, 1900

Misumenoides formosipes (Walckenaer, 1837)

Identification.—This species resembles *Misumena vatia* (Clerck) but can be distinguished from the latter by the presence of a white ridge, or carina, on the clypeus. Males have a distinctly shaped retrolateral tibial apophysis; females have an epigynum with a shallow atrium and a broad, raised hood. Internally, the copulatory tubes are long and folded (Dondale and Redner 1978).

Records.—Roseville: $n = 2$ collections; 2 males.

Biology.—Only two adults were collected in Ramsey County; these were collected in July and August. Fitch (1963) reported that this species matures in late summer in Kansas. In Connecticut, mature males have been taken from late July to late August, and females have been collected through late September (Kaston 1981). Kaston (1981) also indicated that egg sacs of *M. aleatorius* (Hentz) [= *formosipes* (Walck.)] are made in September in Connecticut.

We collected *M. formosipes* by sweeping yellow sweet clover, *Melilotus officinalis* (L.) Pallas and white sweet clover, *M. albus* Medic; and by sweeping grasses and forbs in an open field. Like *Misumena vatia* (Clerck), *Misumenoides formosipes* is known to frequent flowers. Dondale and Redner (1978, p. 130) noted that the habitat of *Misumenoides formosipes* is "found on flowers and foliage of many herbs, shrubs, and deciduous trees in pastures, meadows, orchards, and similar places."

Other recorded habitats for *M. formosipes* in northern regions include: on flowering heads of composites in an elm-maple forest of Illinois (Jones 1940); from shrubs and trees in Ontario (Kurata 1941); on flowers in Wisconsin (Levi and Field 1954); swept from the herbaceous stratum of pine and black oak dunes in the Chicago area (Lowrie 1942); and from pine dunes in Indiana, black oak, *Quercus velutina* Lam., community in Illinois and Indiana, and beech-maple climax forest in Indiana (Lowrie 1948).

Young and Edwards (1990) summarized the collections of *M. formosipes* from numerous field-crop monocultures, which include corn, guar, peanuts, cotton, soybean, and alfalfa in several States. Pimentel and Wheeler (1973) also recorded this crab spider from an alfalfa community in New York.

Genus *Misumena* Latreille, 1804

Misumena vatia (Clerck, 1757)

Identification.—Both males and females of *M. vatia* lack the white carina found in *Misumenoides*. Males of *Misumena vatia* have a stout, hooked retrolateral apophysis on the palpal tibia, and a short truncate ventral apophysis. The embolus arises at the distal end of the tegulum and is short, and spiralled shaped. Females of *M. vatia* have an epigynum with a shallow atrium and small hood; the spermathecae are smooth, and ovoid (Dondale and Redner 1978). Females of *M. vatia* are usually creamy white or yellow, and sometimes have red "shoulder" patches on the anterior dorsolateral surfaces of the abdomen.

Records.—Arden Hills: $n = 4$ collections; 8 males, 6 females. Lauderdale: $n = 16$ collections; 22 males, 4 females. New Brighton: $n = 1$ collection; 1 male. Roseville: $n = 7$ collections; 4 males, 5 females. St. Anthony: $n = 1$ collection; 1 female. St. Paul: $n = 3$ collections; 2 males, 2 females.

Gertsch (1939) reported the collection of a female *M. calycina* (Linneaus, 1757) [= *M. vatia* (Clerck)] from St. Paul, 18 June 1931 (Macy), but gave no habitat information.

Biology.—The biology of this crab spider has been studied in detail by several investigators. Like *Misumenoides formosipes*, females of *Misumena vatia* are capable of changing color, from white to yellow, or *vice versa* (Kaston 1981). Gertsch (1939) reviewed several earlier studies of this color-changing behavior; apparently, only sexually mature spiders are able to change their color (Gabritschevsky 1927).

In Connecticut, Kaston (1981) reported that *Misumena calycina* (Linnaeus) [= *vatia* (Clerck)] matures in May and June and that females may be taken through August. Likewise, in Minnesota we collected adults of both sexes from May through August and a mature female as late as 4 September. However, most (56.4 percent) of our specimens ($n = 55$) were taken in June; 67.7 percent of these were males. Overall, more males ($n = 37$) than females ($n = 18$) were collected. A female taken in mid-August produced an egg sac after collection; the young spiderlings emerged about 2 1/2 weeks later and were released on 4 September. Kaston (1981) also noted an egg sac of this species taken in Connecticut on 12 August. Dondale (1961) found two distinct size-groups, or generations, of *M. vatia* in collections from trees and shrubs in Nova Scotia; he concluded that *M. vatia* is biennial.

Additional details on the biology of *Misumena vatia* are found in the numerous papers by Morse (e.g., 1981, 1985, 1987, 1988a, 1988b) and by Morse and Fritz (1982, 1987, 1989).

The habitats of *M. vatia* are diverse. Kaston (1981, p. 411) stated, "This is one of the most abundant of the flower spiders and has often been called (along with other species) the 'golden-rod spider.' It lives on plants, among the flowers, especially on large flat clusters of Compositae." In Minnesota, we collected this species most frequently (59.4 percent collections; 72.7 percent individuals) by sweeping vegetation of mixed meadow, old field, and prairie-oak savanna habitats. However, we also collected specimens of *M. vatia* from grasses, *Phalaris arundinacea* L.; from forbs, including leaf and flower of goldenrod, *Solidago* sp.; from shrubs, *Cornus* sp., *Ribes* sp.; and from boxelder trees, *Acer negundo* L. A single female was taken on the porch of a house.

Although *M. vatia* generally is considered a "flower spider" of old-field vegetaion, it frequently has been taken from arboreal habitats, including foliage of deciduous and coniferous trees. Jennings and Collins (1987b) summarized the coniferous-tree habitats of *M. vatia*, which included species of *Juniperus*, *Picea*, *Pinus*, and *Pseudotsuga*. Additional records of this species taken from conifers include: on balsam fir, *Abies balsamea* (L.) Mill., and spruce (*Picea* sp.) in Quebec (Belanger and Hutchinson 1992); and on foliage of balsam fir, *Abies balsamea* (L.) Mill., in east-central Maine (Jennings and Dimond 1988). It has also been collected from dwarf mistletoe, *Arceuthobium cyanocarpum* Coulter and Nelson, on limber pine, *Pinus flexilis* James; and from dwarf mistletoe, *A. vaginatum* ssp. *cryptopodum* (Engelm.) Hawksw. and Wiens, on Rocky Mountain ponderosa pine, *Pinus ponderosa* var. *scopulorum* Engelm., in Colorado (Jennings *et al.* 1989).

Other recorded habitats for *M. vatia* in northern regions include: on flowers of trees,

shrubs, and herbs in Manitoba (Aitchison-Benell and Dondale 1990); on herbaceous vegetation in fields, Lake Erie islands, Ohio (Beatty 1988); from marsh, pond, brook, sandhill, fallow fields, pastures, and forested tundra; on apple (*Malus* sp.), shrubs, goldenrod (*Solidago* sp.), and other herbaceous plants in Quebec (Belanger and Hutchinson 1992); on *Kalmia* in Maine (Blake 1926); in a mixed-mesophytic community of Ohio (Cannon 1965); beaten from foliage of apple, *Malus pumila* Mill., trees in Nova Scotia (Dondale 1956) and in Quebec (Dondale *et al.* 1979); from trees and shrubs in Nova Scotia (Dondale 1961); from a mown meadow in Ontario (Dondale 1971); from vegetation of old fields and beaches in Michigan (Drew 1967); from unsprayed apple orchards in Ontario (Hagley 1974); from vegetation of grassland and old field, Itasca State Park, Minnesota (Heimer *et al.* 1984); from an elm-maple forest in east-central Illinois (Jones 1940); from shrubs and trees in Ontario (Kurata 1941); on flowers in Wisconsin (Levi and Field 1954); on yellow flowers of *Berberis, Ranunculus, Potentilla, Solidago, Arnica, Wyethia,* and *Senecio* in the Jackson Hole area of Wyoming (Lowrie 1967); and taken by sweeping from flowers and herbaceous vegetation in North Dakota (Sauer 1972).

Young and Edwards (1990) summarized the habitat associations of *M. vatia* in field-crop monocultures, which included rice, cotton, soybeans, and alfalfa in several States. In addition, Pimentel and Wheeler (1973) found this crab spider in an alfalfa community of New York.

Genus *Coriarachne* Thorell, 1869

Coriarachne versicolor Keyserling, 1880 X *C. utahensis* (Gertsch 1932) "hybrids"

Identification.—In males, the pars pendula extends to the midline of the tegulum and the embolus extends beyond the midline; however, it does not extend as far as that of *C. utahensis*. The palpal tibia has both retrolateral and ventral apophyses; the retrolateral apophysis points at an angle of about 45°. The copulatory tubes of the female extend posteriorly for about one-half the length of the spermathecae (Bowling and Sauer 1975, Dondale and Redner 1978).

Although Bowling and Sauer (1975) and Dondale and Redner (1978) refer to these "intermediates" as "hybrids" that result from crossbreeding of *C. versicolor* and *C. utahensis*, we seriously doubt that the Minnesota specimens are true hybrids. In the 31-year period of this study, neither parental species was collected from any of the investigated habitats. However, Gertsch (1939) recorded both *C. versicolor* and *C. utahensis* from Minneapolis, Hennepin County, Minnesota. Nevertheless, we suspect that the supposed "hybrids" from Ramsey County are a distinct species. We concur with Dondale and Redner (1978) that crossbreeding of the parental species and backcrossing of any hybrids should be attempted.

Records.—Falcon Heights: $n = 1$ collection; 1 female. Lauderdale: $n = 20$ collections; 14 males, 8 females. Roseville: $n = 1$ collection; 1 female. St. Paul: $n = 5$ collections; 4 males, 1 female.

Biology.—In Minnesota, this species apparently overwinters in the penultimate instar. We collected immature males and females in March that molted to maturity in April, and we collected immature males in April that molted to maturity the same month. However, most adults were taken in May (34.5 percent) and June (34.5 percent); few were collected in July (6.9 percent) and September (3.4 percent); where $n = 29$. An adult female was collected as late as 20 September.

In Connecticut, Kaston (1981) reported that *C. versicolor* hibernates in crevices and under bark in the penultimate instar, and reaches maturity in May and June. He also noted that females guarding egg sacs have been taken during the latter half of July.

We collected *C. versicolor* X *utahensis* most frequently (55.6 percent collections; 55.2 percent individuals) from synanthropic habitats in Ramsey County. However, this species also was taken in sweepings of old fields and mixed meadows; on log and on fence; under debris in an *Acer negundo* L. grove; in a *Pinus strobus* L. grove; sweeping understory in a *P. strobus* L. grove; sweeping planted *Picea glauca* (Moench) Voss; and on the trunk of an eastern cottonwood, *Populus deltoides* Marsh.

Dondale and Redner (1978) noted that the habitats of *C. versicolor, C. utahensis,* and *C. versicolor* X *utahensis* "hybrids" were all similar, i.e., "all three forms have been found under the bark scales of many kinds of trees" (*op. cit.*, p. 139). Recorded habitats for *C. versicolor* in northern regions include: on jack pine (*Pinus banksiana* Lamb.) in Michigan (Allen *et al.* 1970); under tree bark, in crevices on tree trunks and buildings, Lake Erie islands, Ohio (Beatty 1988); from apple, *Malus pumila* Mill., trees in Nova Scotia (Dondale 1956); in a mown meadow near Belleville, Ontario (Dondale 1971); under bark of dead northern red oak, *Quercus borealis* Michx., in Minnesota (Heimer *et al.* 1984); from a floodplain oak-elm forest of the Chicago region, Illinois (Holmquist 1926); on larch, *Larix laricina* (DuRoi) K. Koch, infested with the larch sawfly, *Pristiphora erichsonii* (Hartig), in Manitoba (Ives 1967); on the ground in an elm-maple forest of Illinois (Jones 1940); in cracks of bark and on buildings in Wisconsin (Levi and Field 1954); on foliage of balsam fir (*Abies balsamea* (L.) Mill.) in New Bruswick (Loughton *et al.* 1963); swept from the herbaceous stratum of a black oak dune in Illinois (Lowrie 1942); and from pine, black oak, subclimax, and beech-maple climax communities in the Chicago area dunes, Illinois (Lowrie 1948).

Fewer habitat associations are known for *C. utahensis*; they include: on jack pine (*Pinus banksiana* Lamb.) in Michigan (Allen *et al.* 1970); outside a building; beneath bark of maple (*Acer* sp.) in Quebec (Belanger and Hutchinson 1992); in unsprayed apple (*Malus pumila* Mill.) orchards of Ontario (Hagley 1974); collected under bark and debris and in pitfall traps in North Dakota (Sauer 1972); and on foliage of Douglas-fir (*Pseudotsuga menziesii* (Mirbel) Franco) trees in British Columbia (Turnbull 1956).

Genus *Misumenops*
F. O. Pickard-Cambridge, 1900

Misumenops asperatus (Hentz, 1847)

Identification.—The male embolus has a terminal loop with the pars pendula extending nearly to the tip. The retrolateral apophysis of the palpal tibia is bent near the tip. The soft anterior parts of the female copulatory tubes extend far anteriad of the hard parts; the soft parts are not folded as in *M. carletonicus* Dondale & Redner (Dondale and Redner 1978).

Records.—Arden Hills: $n = 2$ collections; 1 male, 1 female. Lauderdale: $n = 5$ collections; 6 males. New Brighton: $n = 3$ collections; 3 males, 2 females. Roseville: $n = 2$ collections; 1 male, 1 female. St. Paul: $n = 3$ collections; 6 males, 2 females.

Biology.—In Minnesota, specimens ($n = 23$) of *M. asperatus* were taken in May, June, and July; however, most (56.5 percent) were collected in May. Immature males collected in September molted to maturity in October and December; likewise, immature females collected in September reached maturity in December and the following February. Kaston (1981) noted that mature specimens of *M. asperatus* were taken in Connecticut from mid-April to October.

Gertsch (1939) described the mating behavior of *M. asperatus*; females with eggs were observed on 12 June. Dondale (1961) concluded that *M. asperatus* is biennial because two distinct size-groups of individuals were found in collections from trees and shrubs in Nova Scotia. Like *Misumena vatia* and *Misumenoides formosipes*, this species reportedly is capable of changing body color from white to yellow and *vice versa*, depending on the color of the substratum (Gertsch 1939).

In Minnesota, we collected *M. asperatus* most frequently (60.0 percent collections; 47.8 percent individuals) by sweeping old fields, mixed meadows, and prairie-oak savanna. A single sweeping collection of disturbed woods at Williams Hill yielded 5 males and 1 female of this species.

Jennings (1976) summarized the arboreal habitats of *M. asperatus*, which included coniferous tree species (*Pinus* spp.) and deciduous tree species (*Diospyros, Juglans, Malus*). The *M. asperatus-Pseudotsuga menziesii* association cited by Jennings (1976) is in error; the associated crab spider was *Misumenops celer* (Hentz), not *M. asperatus*.

Other recorded habitats for *M. asperatus* in northern regions include: on tree foliage, deciduous woods and spruce woods of Manitoba (Aitchison-Benell and Dondale 1990); on vegetation in fields, Lake Erie islands, Ohio (Beatty 1988); from lakeshore, cultivated and

fallow fields; on apple (*Malus* sp.), on cattail (*Typha* sp.), and on common barberry (*Barbarea vulgaris* B. Brady) in Quebec (Belanger and Hutchinson 1992); from an *Aeschna* pond-bog near Pamola Pond, elevation 2,700 ft, Mt. Katahdin, Maine [recorded as *Misumena asperata* Emerton = *Misumenops asperatus* (Hentz)] (Blake 1926); in chestnut oak, *Quercus montana* Willd., forest and old field communities of south-central Ohio (Cannon 1965); from trees and shrubs in Nova Scotia (Dondale 1961); in a mown meadow near Belleville, Ontario (Dondale 1971); dislodged from apple, *Malus pumila* Mill., trees in Quebec (Dondale *et al.* 1979); in a beech-maple forest of Indiana (Elliott 1930); from grassland, Itasca State Park, Minnesota (Heimer *et al.* 1984); in herbs and shrubs of an elm-maple forest in Illinois (Jones 1940); on a flower in Wisconsin (Levi and Field 1954); swept from the herbaceous stratum of black oak dune, mesic pine swale, and peat meadow in the Chicago dunes area, Illinois (Lowrie 1942); in pine, black oak, subclimax, and beech-maple climax communities of the Chicago area, Illinois (Lowrie 1948); and, collected by sweeping wild flowers and grasses, never in pitfall traps, in North Dakota (Sauer 1972).

Young and Edwards (1990) summarized the numerous habitat associations of *M. asperatus* with field-crop monocultures, which include grain sorghum, rice, sugarcane, corn, peanuts, cotton, soybean, and alfalfa. In addition, Pimentel and Wheeler (1973) reported this crab spider from an alfalfa community in New York.

Misumenops celer (Hentz, 1847)

Identification.—The male embolus has a terminal spiral; however, the pars pendula does not extend to the tip as in *M. asperatus*. The male embolus is slender and originates beyond 180°. The ventral margin of the retrolateral tibial apophysis is only slightly angulate. In females, the soft parts of the copulatory tubes are not folded, and the soft parts extend anteriad as far as the hard parts (Dondale and Redner 1978).

Records.—Lauderdale: $n = 3$ collections; 2 males, 2 females. Roseville: $n = 6$ collections; 4 males, 3 females.

Biology.—In Minnesota, adults ($n = 11$) were collected only in June (54.6 percent) and in July (45.5 percent). We suspect that this species overwinters as immatures that reach maturity by early summer. Kaston (1981, p. 416) reported that "Adults have been taken, in the north, from May to September by sweeping grassland flowers, ..." He further indicated that this species has not been taken from Connecticut, but is known from Massachusetts and New York.

In Oklahoma, Muniappan and Chada (1970) reported on the biology of *M. celer*, including mating behavior, oviposition, hatching, and development of instars in the laboratory. They also reported on population fluctuations of *M. celer* in an alfalfa field. Plagens (1983) also gives seasonal abundance data for this crab spider in two Arizona cotton fields. Richman *et al.* (1990) included *M. celer* among the dominant species of spiders found in alfalfa fields of New Mexico.

In Minnesota, we collected *M. celer* only by sweeping herbaceous vegetation in old fields and mixed meadows. Specific plant associations of *M. celer* included sweepings of yellow sweet clover, *Melilotus officinalis* (L.) Pallas and of white sweet clover, *M. albus* Medic.

The habitat associations of *Misumenops celer* are diverse and include the blossoms and foliage of many kinds of plants, especially those in the Southeastern, Southern, Midwestern, and Southwestern United States. Few habitats have been recorded for *M. celer* in the Northern States and Provinces; however, they include: from a black oak (*Quercus velutina* Lam.) community in Illinois (Lowrie 1948); and on foliage of Douglas-fir (*Pseudotsuga menziesii* (Mirbel) Franco) in British Columbia (Turnbull 1956).

Young and Edwards (1990) summarized the field-crop associations of *M. celer*, which included grain sorghum, rice, sugarcane, corn, guar, peanuts, cotton, and soybean.

Genus *Ozyptila* Simon, 1864

Ozyptila conspurcata Thorell, 1877

Identification.—The basal tegular ridge of the male palpus is broad but lacks teeth; however, the tegulum has a small divided tooth near the center. Females are readily distinguished by the Y-shaped atrium just posterior to the short, wide hood of the epigynum (Dondale and Redner 1975b, 1978).

Records.—Lauderdale: $n = 6$ collections; 6 females. St. Paul: $n = 4$ collections; 2 males, 3 females.

Biology.—In Minnesota, adult specimens ($n = 11$) of *O. conspurcata* were collected in April, May, June, and October; most (45.4 percent) were taken in April. Only 2 males were collected, both in June. The remaining specimens were adult females, which made up 81.8 percent of all adults collected.

We collected *O. conspurcata* most frequently (50 percent collections; 45.4 percent individuals) under rocks in old fields and in mixed meadows. Specimens also were found under boards in an *Acer negundo* grove; under a board in a disturbed field; and on a board in a white pine grove. Males ($n = 2$) were found exclusively on fences. Dondale and Redner (1978) noted that specimens of *O. conspurcata* have been collected in fields, in pine and fir forests, and occasionally in talus on high mountains. They also reported that specimens have been taken from bird nests. Bultman *et al.* (1982) found this species in an old field in western Michigan. Chickering (1940) and Snider (1991) also recorded this species from Michigan but gave no habitat information. Brady *et al.* (1991) pitfall-trapped *O. conspurcata* exclusively in old-field habitats of western Michigan. Cutler *et al.* (1975) captured numerous specimens of *O. bryantae* Gertsch [= *O. conspurcata* Thorell] in pitfall traps deployed in *Larix* and *Populus* stands of northern Minnesota. Other known habitat associations for *O. conspurcata* in northern regions include: on moss in bogs, meadows, and deciduous woods of Manitoba (Aitchison-Benell and Dondale 1990); in a mown meadow near Belleville, Ontario (Dondale 1971); captured in pitfall traps set in a mixed-boreal forest of Ontario (Freitag *et al.* 1969); in soil and litter samples from oak-hickory (*Quercus-Carya*) and floodplain (*Ulmus-Acer-Platanus-Salix*) forests in Indiana (Gasdorf and Goodnight 1963); and taken in pitfall traps in North Dakota (Sauer 1972).

Genus *Xysticus* C. L. Koch, 1835

pellax Group

Xysticus pellax O. P.-Cambridge, 1894

Identification.—Males of *X. pellax* closely resemble males of *X. gulosus* Keyserling; however, males of *X. pellax* usually are reddish brown rather than gray, the cymbium of the palpus lacks a conspicuous swelling, and the conductor is short (Dondale and Redner 1978). Females of these two species are more difficult to separate; females of *X. pellax* have atrial sclerites that are usually round rather than oval, and internally the copulatory tubes are smoothly rounded rather than angular anterior to the spermathecae (Turnbull *et al.* 1965, Dondale and Redner 1978).

Record.—New Brighton: $n = 1$ collection; 1 male.

Biology.—Dondale (1977) gives life history data for both *X. pellax* and *X. gulosus* in Ontario. He concluded that both species have annual life histories, with maturity and mating in late summer or early autumn and oviposition the following spring. Our single collection of a penultimate male in July, which reached maturity in early August, corresponds with this late-summer maturation period. Gertsch (1939) reported a male of *X. pellax* was collected as late as November in Wisconsin; but in northeastern states (i.e., Maine, Vermont, New Hampshire, and New York) males were taken most frequently in September. Females of *X. pellax* have been taken in September in Maine and Nova Scotia (Gertsch 1953).

Although Turnbull *et al.* (1965) and Dondale and Redner (1978) indicate that *X. pellax* is terricolous (i.e., taken in pitfall traps), our single collection by sweeping *Bromus inermis* Leyss. provides an above-ground, specific spider-plant association. Additional recorded habitats for this species in northern regions include: cultivated and uncultivated fields, roadside, near a wood and borders of a forest in Quebec (Belanger and Hutchinson 1992); in a wheat field and grassy borders in Saskatchewan (Doane and Dondale 1979); in a mown meadow in Ontario (Dondale 1971, 1977); on juniper bushes, Beaver Island, Michigan (Drew 1967); and in hayfields and their margins in Nova Scotia (Fox and Dondale 1972).

Xysticus gulosus Keyserling, 1880

Identification.—Males of *X. gulosus* closely resemble those of *X. pellax* O. P.-Cambridge; however, they are usually gray brown rather than red brown. The cymbium of the male palpus is conspicuously swollen along the distal

retrolateral margin, and the conductor is long. The atrial sclerites of the female epigy-num are usually oval rather than round, and the anterior loop of the copulatory tubes is usually angular (Turnbull *et al.* 1965, Dondale and Redner 1978).

In Minnesota, we collected one female whose overall body coloration was gray. Externally, the atrial sclerites of the female epigynum were oval; however, internally, the copulatory tubes were looped like those illustrated for *X. pellax* (i.e., figs. 551-553, Dondale and Redner 1978). Turnbull *et al.* (1965) noted that the females of *X. pellax* and *X. gulosus* are difficult to separate and that further work is needed on this problem.

Records.—Arden Hills: $n = 1$ collection; 1 female. Falcon Heights: $n = 1$ collection; 1 male. Lauderdale: $n = 1$ collection; 1 female. Roseville: $n = 2$ collections; 1 male, 1 female. St. Paul: $n = 1$ collection; 1 male.

Biology.—In Minnesota, this species apparently matures in late summer to early fall. Adult specimens ($n = 6$) were taken only in September and October. In Ontario, Dondale (1977) concluded that this species has an annual life history, with maturity and mating in late summer or early autumn and oviposition the following spring. He found males of *X. gulosus* from 30 August to 31 October, females from late September to late October, and females with egg sacs in May and early June.

We collected *X. gulosus* in Minnesota by sweeping grasses and forbs; sweeping disturbed prairie; on sandy path, mixed meadow; and in synanthropic habitats (i.e., inside house, and on sidewalk).

Turnbull *et al.* (1965) reported a partial habitat difference between *X. gulosus* and *X. pellax*, with *X. gulosus* taken only above ground level (e.g., on buildings, trees, or shrubs); *X. pellax* was taken only in pitfall traps. However, Dondale (1971) and Sauer (1972) noted that adults of both species have been taken in pitfall traps. Nevertheless, our Minnesota data generally agree with the aboveground habitats for *X. gulosus.*

The recorded habitat associations of *X. gulosus* in northern regions include: from foliage of apple (*Malus pumila* Mill.) trees in Nova Scotia (Dondale 1956); in a mown meadow near Belleville, Ontario (Dondale 1971, 1977); from vegetation of old fields and under stones at field-wood's edge in Michigan (for *X. gulosa* Keyserling, 1880) (Drew 1967); in an oak-elm (*Quercus-Ulmus*) forest of the Chicago region, Illinois (Holmquist 1926); on vegetation in fields and woods, and under stones in Wisconsin (Levi and Field 1954); swept from the herbaceous stratum of foredune, pine, black oak dune, and peat meadow communities in the Chicago area, Illinois (Lowrie 1942); from foredune, black oak dune, subclimax, and beech-maple climax communities in the Chicago area, Illinois (Lowrie 1948); and in uncovered pitfall traps placed in an old field in North Dakota (Sauer 1972).

This species also occupies field-crop monocultures including peanuts, cotton, soybean, and alfalfa (Young and Edwards 1990). Pimentel and Wheeler (1973) also recorded *X. gulosus* from an alfalfa community in New York.

locuples Group

Xysticus bicuspis Keyserling, 1887

Identification.—The distal tegular apophysis of the male palpus has a distinct "heel," and is about as long as the ventral tegular apophysis. The atrial sclerites of the female epigynum are short and lack a concavity between the sclerites. They also lack the prominent copulatory tubes found in other members of the *locuples* group (Turnbull *et al.* 1965, Dondale and Redner 1978).

Record.—Lauderdale: $n = 2$ collections; 2 males.

Biology.—Not much is known about the biology of this species. In Minnesota, only two adults, both males, were collected in April and May; both were associated with mixed meadow.

Dondale and Redner (1978) noted that specimens of *X. bicuspis* have been collected by sweep nets and pitfall traps in wooded areas. Additional recorded habitats for this species include: from under leaves and in sweeping low bushes in Connecticut (Kaston 1981); and on the ground in rubbish in Ontario (Kurata 1941).

Young and Edwards (1990) included one record of *X. bicuspis* associated with cotton in Alabama. Sauer (1972) also reported this species taken by sweeping net in North Dakota, but gave no information on habitat.

Xysticus ampullatus Turnbull, Dondale, and Redner, 1965

Identification.—The ventral apophysis on the male palpal tibia is distinctly expanded, and the distal tegular apophysis is slender and without a distinct "heel." The atrial sclerites of the female epigynum are well separated, and the copulatory tubes are large and conspicuous; the spermathecae are smooth and not angled at midlength (Turnbull *et al.* 1965, Dondale and Redner 1978).

Records.—Arden Hills: $n = 1$ collection; 1 female. Lauderdale: $n = 1$ collection; 1 male.

Biology.—Not much is known about the biology of this species, which was first described in 1965. Only two specimens were collected in Ramsey County; both were taken in June. One female was collected by sweeping mixed meadow, with minor prairie elements; one male was taken by sweeping oak meadow.

In Ontario, the type specimens (holotype, allotype, paratypes) were collected in June and July (Turnbull *et al.* 1965). Turnbull *et al.* (1965) also noted that all available specimens were collected by pitfall traps in partly wooded areas. However, Dondale and Redner (1978) indicated that pitfall-trap collections of *X. ampullatus* have been made along the margins of meadows as well as sparsely wooded areas. Additional recorded habitats for *X. ampullatus* include: from an ombrotrophic bog, beaver pond, shores of a waterway, dune, fallow field, and borders of a deciduous forest; and under rocks and stones in Quebec (Belanger and Hutchinson 1992); in a mown meadow near Belleville, Ontario (Dondale 1971); from hayfields and their margins in Nova Scotia (Fox and Dondale 1972); and sweeping deciduous forest and red pine (*Pinus resinosa* Aiton) forest in the Itasca State Park of Minnesota (Heimer *et al.* 1984).

In Maine, *X. ampullatus* has been taken in pitfall traps deployed in an old field and by sweeping old-field vegetation (Jennings unpublished).

Xysticus chippewa Gertsch, 1953

Identification.—The ventral apophysis of the male palpal tibia is slender rather than swollen, and the distal tegular apophysis has a shallow undulation in the basal margin. The atrial sclerites of the female epigynum converge posteriorly, and the spermathecae are distinctly grooved (Gertsch 1953, Turnbull *et al.* 1965, Dondale and Redner 1978).

Record.—Roseville: $n = 1$ collection; 1 male.

Biology.—Not much is known about the biology of this species. A single male was collected in Ramsey County by sweeping grasses and forbs in a mixed meadow in June. In Michigan, adult specimens have been taken in July and August; and in Ontario in June (Gertsch 1953). In North Dakota, Sauer (1972) noted that specimens of *X. chippewa* were taken from 16 June to 2 July. Based on these observations, we conclude that this species matures in midsummer in northern latitudes.

Recorded habitats for *X. chippewa* include: from ground litter of bogs and lake shores in Manitoba (Aitchison-Benell and Dondale 1990); taken by sweeping net in a wooded area of North Dakota (Sauer 1972); and collected by sweeping forest herbs in Canada (Dondale and Redner 1978). Snider (1991) reported that this species has been taken in Michigan, but gave no habitat information. Apparently, this species is rarely collected.

Xysticus discursans Keyserling, 1880

Identification.—The distal tegular apophysis of the male palpus is about as wide as it is long. Females have the atrial sclerites arched laterad, and the copulatory tubes are straight, moderately long, and extend posteriorly between the spermathecae (Turnbull *et al.* 1965, Dondale and Redner 1978).

Records.—Lauderdale: $n = 6$ collections; 4 males, 2 females. Roseville: $n = 1$ collection; 1 female. St. Paul: $n = 4$ collections; 3 males, 1 female.

Biology.—In Minnesota, adults ($n = 8$) of *X. discursans* were taken only in May and June. An immature female collected in April reached maturity in May; likewise, an immature male collected in October reached maturity in

November. However, an immature female also collected in October did not mature until the following February.

In Ontario, Dondale (1977) concluded that *X. discursans* has a biennial life history with maturity and mating in the spring. He also indicated that there were two generations in the field throughout the autumn, winter, and early spring, and three generations during the summer months in Ontario. We made no attempt to identify the immatures of this species in Minnesota.

We collected *X. discursans* most frequently from three generalized habitats—synanthropic, old field-mixed meadow, and fences (27.3 percent collections; 27.3 percent individuals, each habitat). Other habitats included: under a board, clay soil; and on a sidewalk, University of Minnesota, St. Paul Campus.

The recorded habitats of *X. discursans* in northern regions include: from grass of mixed prairie and river banks in Manitoba (Aitchison-Benell and Dondale 1990); near a stream, in cultivated and fallow fields, and in a gravel pit of Quebec (Belanger and Hutchinson 1992); from heading bluegrass, *Poa pratensis* L., in Minnesota (Cutler 1971); in a wheat field and its grassy borders in Saskatchewan (Doane and Dondale 1979); in a mown meadow near Belleville, Ontario (Dondale 1971, 1977); from hayfields and their margins in Nova Scotia (Fox and Dondale 1972); on red spruce, *Picea rubens* Sarg., foliage in Maine (Jennings and Collins 1987a); captured in pitfall traps deployed in strip-clearcut and dense spruce-fir forests of Maine (Jennings *et al.* 1988); taken both by sweeping and in pitfall traps in North Dakota (Sauer 1972); and in an overgrazed pasture in eastern Ontario (Turnbull 1966).

Young and Edwards (1990) noted that *X. discursans* has been taken from soybean in Kentucky and from alfalfa in Kentucky, New York, and Virginia. Pimentel and Wheeler (1973) also reported this species from an alfalfa commmunity in New York. In North Dakota, Sauer (1972) collected this species by sweeping and in pitfall traps, but gave no information about communities or habitats.

Xysticus triguttatus Keyserling, 1880

Identification.—The distal part of the male embolus is distinctly flattened. The copulatory tubes of the female epigynum are short and arched mesially; they do not bend posteriorly (Turnbull *et al.* 1965, Dondale and Redner 1978).

Records.—Arden Hills: $n = 1$ collection; 1 male. Lauderdale: $n = 8$ collections; 11 males, 6 females. New Brighton: $n = 1$ collection; 2 females. Roseville: $n = 13$ collections; 21 males, 15 females. St. Paul: $n = 1$ collection; 1 female.

Biology.—In Minnesota, adults ($n = 57$) of *X. triguttatus* were collected in June, July, and August; however, most (66.7 percent) were collected in June. Females ($n = 24$) were collected all three summer months; males ($n = 33$) were taken only in June and July, but mostly in June (75.8 percent).

This species commonly inhabits vegetation of old fields and mixed meadows. We collected *X. triguttatus* chiefly (83.3 percent collections; 93.0 percent individuals) by sweeping herbaceous vegetation of old fields, mixed meadows, disturbed prairie, and disturbed prairie-oak savanna. A few additional specimens were taken on *Solidago* and by sweeping yellow sweet clover, *Melilotus officinalis* (L.) Pallas.

Dondale and Redner (1978) noted that collections of *X. triguttatus* have been made by pitfall traps in grassland and by sweep nets in herbs and shrubs. Additional recorded habitats of *X. triguttatus* in northern regions include: on grass and shrub foliage of prairies and fields in Manitoba (Aitchison-Benell and Dondale 1990); on jack pine, *Pinus banksiana* Lamb., in Michigan (Allen *et al.* 1970); on vegetation or ground, Lake Erie islands, Ohio (Beatty 1988); near a pond, grassy and open side of a hill, in moss and lichen of Quebec (Belanger and Hutchinson 1992); from vegetation of old fields in Michigan (Drew 1967); from hayfields and their margins in Nova Scotia (Fox and Dondale 1972); from grassland, buildings, and fern in the Itasca State Park of Minnesota (Heimer *et al.* 1984); swept from the herbaceous stratum of pine and black oak dunes in the Chicago area, Illinois (Lowrie 1942); from a foredune

association in Illinois, and from black oak dunes in Illinois and Indiana (Lowrie 1948); on crowns of young red pine, *Pinus resinosa* Aiton, in Ontario (Martin 1966).

Young and Edwards (1990) reported that *X. triguttatus* has been taken from cotton, soybean, and alfalfa monocultures in several States.

funestus Group

Xysticus elegans Keyserling, 1880

Identification.—Males of *X. elegans* have a broad distal tegular apophysis on the palpus. The atrium of the female epigynum extends anteriorly under the epigynum rim; the copulatory tubes are barely visible in dorsal view, and the spermathecae are smoothly arched (Turnbull *et al.* 1965, Dondale and Redner 1978).

Records.—Arden Hills: $n = 1$ collection; 1 male. Lauderdale: $n = 2$ collections; 1 male, 1 female. New Brighton: $n = 2$ collection; 2 females.

Biology.—Kaston (1981) indicated that this species apparently overwinters in the penultimate and younger instars. Our collections of *X. elegans* in Minnesota correspond with a late spring-early summer maturation period, i.e., adults were collected only in May and June. An immature female collected 23 April 1977 molted to maturity the following day; an immature female taken 27 September 1995 and reared in the laboratory did not reach maturity until 7 December 1995. These observations confirm a late spring-early summer maturation period. In Connecticut, Kaston (1981) found females of *X. elegans* from May through September and males in May and June.

This species occupies diverse habitats including the ground, herb, shrub, and tree layers. However, in Minnesota we collected *X. elegans* chiefly by sweeping vegetation (mostly *Corylus* sp.) of old field, prairie, and mixed-meadow habitats. One male was taken inside a house; a female was found under debris in an old field.

Dondale and Redner (1978) noted that collections of *X. elegans* have been made by pitfall traps in partly wooded areas; they also noted that specimens have been taken in leaf litter, under stones and logs, and occasionally on herbaceous plants. Other recorded habitats for *X. elegans* in northern regions include: in leaf litter of deciduous woods, prairies, and meadows in Manitoba (Aitchison-Benell and Dondale 1990); on foliage of jack pine, *Pinus banksiana* Lamb., in Michigan (Allen *et al.* 1970); near a pond, lakeshore, field, deciduous forests and their edges, grassy glade; on oaks (*Quercus* sp.), maple (*Acer* sp.), and apple (*Malus* sp.); from shrubs and grasses of Quebec (Belanger and Hutchinson 1992); pitfall-trapped in an oak (*Quercus velutina* Lam. and *Q. alba* L.) forest, and in a beech-maple (*Fagus grandifolia* Ehrh.-*Acer saccharum* Marsh.) forest of western Michigan (Brady *et al.* 1991); in subclimax oak (*Quercus*) and beech-maple (*Fagus-Acer*) forests of Michigan (Bultman *et al.* 1982); on eastern white pine, *Pinus strobus* L., infested with the introduced pine sawfly, *Diprion similis* (Htg.), in Wisconsin (Coppel and Smythe 1963); in pitfall traps set in eastern larch, *Larix laricina* (Du Roi) K. Koch), and aspen, *Populus tremuloides* Michx., stands of northern Minnesota (Cutler *et al.* 1975); from apple, *Malus pumila* Mill., trees in Nova Scotia (Dondale 1956); from vegetation of old fields and under stones at field-wood's edge in Michigan (Drew 1967); from hayfields and their margins in Nova Scotia (Fox and Dondale 1972); captured in pitfall traps deployed in a mixed boreal forest of northwestern Ontario (Freitag *et al.* 1969); in linear pitfall traps deployed in spruce-fir forests of west-central Maine (Hilburn and Jennings 1988); extracted from litter samples in aspen, *Populus grandidentata* Michx. and *P. tremuloides* Michx., and red maple, *Acer rubrum* L., stands of the Moosehorn National Wildlife Refuge, Maine (Jennings *et al.* 1990); on ground in an elm-maple (*Ulmus americana* L., *U. fulva* Michx.-*Acer saccharum* Marsh.) climax forest in Illinois (Jones 1940); sweeping tall grass, sifting dead leaves, and in the flower of Queen Anne's lace, *Daucus carota* L., in Connecticut (Kaston 1981); swept from the herbaceous stratum of a black oak, *Quercus velutina* Lam., dune in Illinois (Lowrie 1942); from black oak, subclimax, and beech-maple climax communities in the Chicago area (Lowrie 1948); from crowns of young red pine, *Pinus resinosa* Aiton, in Ontario (Martin 1966); taken in large numbers in pitfall traps, especially in partially wooded areas of North Dakota (Sauer 1972); on foliage of Douglas-fir, *Pseudotsuga menziesii* (Mirbel) Franco, in British Columbia

(Turnbull 1956); captured in pitfall traps deployed in a streamside *Acer-Celtis-Quercus* forest (Uetz 1976), and in a mixed-oak forest of Illinois (Uetz 1979); in pitfall traps deployed in a balsam fir (*Abies balsamea* (L.) Mill.)-red spruce (*Picea rubens* Sarg.)-red maple (*Acer rubrum* L.)-trembling aspen (*Populus tremuloides* Michx.) stand of New Brunswick (Varty and Carter 1974).

X. elegans has been taken from two field-crop monocultures: cotton in Alabama and Texas, and soybean in Illinois (Young and Edwards 1990).

luctans Group

Xysticus luctans (C. L. Koch, 1845)

Identification.—The distal apophysis of the male palpus is "heeled," and the basal apophysis does not extend to the margin of the tegulum. The female epigynum has an extensive atrial ledge with a deep notch; the atrium is wider posteriorly than anteriorly (Turnbull *et al.* 1965, Dondale and Redner 1978).

The color pattern of *X. luctans* is distinctive; i.e., two brown longitudinal lines are found laterally on the carapace, and the dorsum of the abdomen has paired brown spots separated by off-white areas (see fig. 616, Dondale and Redner 1978). Juveniles of this species are readily recognized by the distinctive color pattern.

Records.—Lauderdale: $n = 4$ collections; 4 males, 2 females. Roseville: $n = 4$ collections; 3 males, 2 females.

Biology.—Adults ($n = 11$) of *X. luctans* were collected in June and July in Minnesota; however, most (81.8 percent) were taken in June. Juveniles were collected in August, September, and October; two penultimate females of this species were taken in September. We suspect that *X. luctans* overwinters as subadults in Minnesota and reaches maturity by early summer. Conversely, Worley and Pickwell (1927) reported that *X. luctans* hibernates in the adult stage in Nebraska. Kaston (1981) noted that in Connecticut mature individuals were most abundant from May to July; however, females were taken through October.

We collected *X. luctans* in Minnesota chiefly by sweeping vegetation of old fields and mixed meadows (50.0 percent collections; 45.4 percent individuals). Additional habitats for this species in Ramsey County included: sweeping *Solidago* sp., sweeping *Melilotus albus* L.; on red clay bank; and sweeping oak meadow.

In addition to the Minnesota habitats, *X. luctans* has been collected by pitfall traps and vacuum collectors in grasslands and less commonly in crops and weeds (Dondale and Redner 1978). Other recorded habitats for *X. luctans* in northern regions include: on grass in meadows of Manitoba (Aitchison-Benell and Dondale 1990); in a cultivated field of Quebec (Belanger and Hutchinson 1992); in an old field community of western Michigan (Bultman *et al.* 1982); in a mown meadow near Belleville, Ontario (Dondale 1971); from old fields and grassy juniper stands of Michigan (Drew 1967); from hayfields and their margins in Nova Scotia (Fox and Dondale 1972); on the ground in rubbish in Ontario (Kurata 1941); from black oak dune in Illinois (Lowrie 1942, 1948); and taken in pitfall traps or with a vacuum insect net in North Dakota (Sauer 1972).

Xysticus emertoni Keyserling, 1880

Identification.—The basal tegular apophysis of the male palpus extends beyond the edge of the cymbium; the distal tegular apophysis is "heeled." Females of *X. emertoni* have a rounded atrium with an atrial ledge that occupies about two-thirds of the atrium (Turnbull *et al.* 1965, Dondale and Redner 1978).

Records.—Arden Hills: $n = 1$ collection; 1 female. Lauderdale: $n = 9$ collections; 3 males, 7 females. Roseville: $n = 3$ collections; 1 male, 4 females.

Biology.—In Minnesota, adults ($n = 16$) of *X. emertoni* were collected in June and July; however, most (87.5 percent) were taken in June. Females (75 percent of all specimens) were collected both months; males ($n = 4$) were taken only in June. Kaston (1981) noted that both sexes have been found in June and July from Massachusetts and further north.

This species is usually collected from vegetation of old fields and mixed meadows. In Minnesota, we collected *X. emertoni* chiefly (76.9 percent collections; 81.2 percent individuals) by

sweeping old fields, mixed meadows, and oak meadow. Additional specimens (n = 3) were collected by sweeping specific plants (i.e., *Phalaris arundinacea* L. and *Solidago* sp.) and on a red clay bank.

In Canada, Dondale and Redner (1978) noted that *X. emertoni* has been taken by pitfall traps in fields, meadows, and bogs, and occasionally by sweep nets from herbaceous plants. Additional recorded habitats for *X. emertoni* in the Northern States and Provinces include: from grass and leaf litter of coniferous and deciduous woods, and meadows in Manitoba (Aitchison-Benell and Dondale 1990); from lakeshore, uncultivated field, gravel pit, open coniferous forest; on shrubs and grasses; and under stones in Quebec (Belanger and Hutchinson 1992); in a wheat field in central Saskatchewan (Doane and Dondale 1979); from hayfields and their margins in Nova Scotia (Fox and Dondale 1972); from an old field in the Itasca State Park of Minnesota (Heimer *et al.* 1984); captured in linear pitfall traps deployed in spruce-fir forests of west-central Maine (Hilburn and Jennings 1988); in pitfall traps deployed in strip-clearcut areas of spruce-fir forests of northern Maine (Jennings *et al.* 1988); from the herbaceous stratum of the Jackson Hole region of Wyoming (Lowrie 1968); and, in pitfall traps in North Dakota (Sauer 1972).

Xysticus obscurus Collett, 1877

Identification.—As in *X. luctans* and *X. emertoni*, the distal tegular apophysis of the male palpus is "heeled." However, the basal tegular apophysis is broad and extends to the margin of the cymbium. Females have a small atrial ledge, and the copulatory tubes are joined at midline (Turnbull *et al.* 1965, Dondale and Redner 1978).

The single female collected in Minnesota resembles this European species; however, the atrial ledge is less pronounced and has a definite indentation at midline. The copulatory tubes appear to be joined at midline, but they lack distinctive sclerotization. The identity of this species has been confirmed by James H. Redner, Biosystematics Research Centre, Ottawa.

Record.—Lauderdale: n = 1 collection; 1 female.

Biology.—Little is known about the biology of this species in North America. It is known from Norway and Sweden (Turnbull *et al.* 1965) and probably was introduced into North America. In Minnesota, a single female was collected by sweeping mixed meadow in June.

In Canada, Dondale and Redner (1978) noted that specimens of *X. obscurus* have been collected by pitfall traps and from wasp nests in coniferous forests. Other recorded habitats for this species in North America include: in litter of bogs and mixed woods of Manitoba (Aitchison-Benell and Dondale 1990); captured in pitfall traps deployed in larch, *Larix laricina* (Du Roi) K. Koch, stands of northern Minnesota (Cutler *et al.* 1975); from wasps nests, and captured in pitfall traps deployed in spruce forest of Ontario (Turnbull *et al.* 1965). Like *X. chippewa*, specimens of *X. obscurus* are seldom taken in faunistic surveys.

cunctator Group

Xysticus banksi Bryant, 1931

Identification.—Males of *X. banksi* have a prominent apical sclerite on the palpus that is elongate, handlike and with several teeth at the tip. Females of this species have a rounded atrium with the median septum of the epigynum about one-half the length of the atrium (Turnbull *et al.* 1965, Dondale and Redner 1978).

Record.—New Brighton: n = 1 collection; 1 male, 1 female.

Biology.—In more southern regions, Gertsch (1953) reported that females of *X. banksi* have been taken as early as April in North Carolina and May in New York; however, most records for females taken in Massachusetts, New York, and New Jersey were in June and July (Gertsch 1939, 1953). Gertsch (1939) noted that the male and female types of *X. banksi* were taken in June in Massachusetts. Our single collection of both penultimate male and female of *X. banksi* in late July, followed by maturity in November in the laboratory, possibly indicates that this species matures in autumn or overwinters as immatures in Minnesota.

Turnbull *et al.* (1965) indicated that *X. banksi* is a rare species in Canada; however, Dondale and Redner (1978) reported that *X. banksi* had

been collected by pitfall traps and by hand in litter of fields and beaches of Canada. Kaston (1981, p. 428) noted that: "A pair of this uncommon species was found by Bryant [Elizabeth B.] on the beach under trash, in June. The female was guarding an egg sac which was flat on one side, 4 mm high and 9 mm in diameter." Lowrie (1948) included *X. banksi* among the spiders taken from the herbaceous statum of subclimax communities in the Chicago area dunes. He also noted that *X. banksi* had been taken from foredune and black oak communities in Illinois, and from a beech-maple community in Indiana (Lowrie 1948). In Maryland, Muma (1944) reported that a female of *X. banksi* was taken by sweeping in an orchard. Snider (1991) noted that *X. banksi* had been taken in two counties in Michigan, but gave no habitat information; likewise, Moulder (1992) included this species among the checklist of Illinois spiders but without habitat information. This species has been collected sweeping sand prairie in Anoka County, Minnesota (B. Cutler, personal observation).

ferox Group

Xysticus ferox (Hentz, 1847)

Identification.—The male palpus has a short, curved basal tegular apophysis; the distal apophysis is "T" shaped. The median septum of the female epigynum broadens posteriorly; and the copulatory tubes are situated at midline (Turnbull *et al.* 1965, Dondale and Redner 1978).

Records.—Arden Hills: $n = 1$ collection; 1 male. Lauderdale: $n = 10$ collections; 10 males, 8 females. St. Paul: $n = 4$ collections; 1 male, 3 females.

Biology.—In Minnesota, adults ($n = 20$) of *X. ferox* were collected in May and June; however, most (90.0 percent) were taken in June. Immature females collected in April and May reached maturity in May and June, respectively. An immature female collected in October molted to maturity in December.

Kaston (1981) indicated that in Connecticut this species passes the winter in the penultimate instar, with males maturing in April and May, and females in May. He further indicated that both sexes continue to be found through August. Mating behavior of *X. ferox* was first described by Montgomery (1903) and later by Gertsch (1939). Mating occurs in May with egg sac construction in June and July (Kaston 1981).

This species apparently inhabits all strata, including the ground, herb, shrub, and tree layers. In Ramsey County, we collected *X. ferox* most frequently (46.7 percent collections; 47.8 percent individuals) by sweeping old fields and mixed meadows, including meadows with minor prairie elements. Other habitats for this species included: on a fence; on a board in mixed meadow; under cardboard in an old field; under a board in disturbed woods feeding on an ant (*Lasius* sp.); on a sidewalk; on the outside of building; in pitfall trap, *Populus alba* L. grove; and in pitfall trap at edge of *Typha-Salix* marsh.

Dondale and Redner (1978) reported that specimens of *X. ferox* have been collected in pitfall traps, by hand under stones and logs, and less often by sweeping flowering herbs. Kaston (1981) also noted that specimens have been collected from under stones, logs, and bark, and by sweeping bushes.

Although frequently collected on the ground, and less frequently from the herb-shrub layer, this species also occupies arboreal habitats. The arboreal habitats of *X. ferox* include conifers (e.g., *Abies, Pseudotsuga, Pinus*) and deciduous trees (e.g., *Juglans, Diospyros,* and *Malus*) (Jennings 1976).

Other recorded habitats for *X. ferox* in northern regions include: from leaf litter and grass of deciduous woods, fields, and meadows in Manitoba (Aitchison-Benell and Dondale 1990); on vegetation or ground, Lake Erie islands, Ohio (Beatty 1988); near a pond, lakeshore, cultivated and fallow fields, borders of coniferous and deciduous forests, grassy clearing; on vegetation in Quebec (Belanger and Hutchinson 1992); pitfall-trapped in an oak (*Quercus velutina* Lam., *Q. alba* L.) forest of western Michigan (Brady *et al.* 1991); in a beech-maple forest of Ohio (Bultman and Uetz 1982); in old field and subclimax oak forest of western Michigan (Bultman *et al.* 1982); captured in pitfall traps deployed in aspen, *Populus tremuloides* Michx., stands of northern Minnesota (Cutler *et al.* 1975); from grassy borders of wheat fields in central

Saskatchewan (Doane and Dondale 1979); under debris in dumps and on juniper (*Juniperus communis* var. *depressa*) bushes in Michigan (Drew 1967); from a beech-maple forest in Indiana (Elliott 1930); on ground in rubbish in Ontario (Kurata 1941); from a black oak, *Quercus velutina* Lam., dune in Illinois (Lowrie 1942, 1948), and from beech-maple (*Fagus-Acer*) climax forest in Michigan and Indiana (Lowrie 1948).

Young and Edwards (1990) summarized the habitat associations of *X. ferox* with various field-crop monocultures, which included sugarcane in Louisiana, soybean in Illinois and Kentucky, and alfalfa in Kentucky.

montanensis Group

Xysticus punctatus Keyserling, 1880

Identification.—The tegular ridge of the male palpus is near the center, and the hook of the ventral tibial apophysis is very small. The female epigynum has a small, flat medium septum, which extends only slightly outside the atrium (Turnbull *et al.* 1965, Dondale and Redner 1978).

Records.—Roseville: $n = 4$ collections; 3 males, 2 females.

Biology.—In Minnesota, two penultimate males collected in September, and reared in the laboratory, reached maturity in October; one penultimate male collected in September reached maturity in November. Based on these observations, we suspect that this species overwinters as subadults in Minnesota. Dondale (1961) indicated that *X. punctatus* is biennial because two distinct size-groups, or generations, were present in autumn collections made in eastern Canada.

We collected *X. punctatus* only by beating foliage of white pine, *Pinus strobus* L., in Ramsey County.

Turnbull *et al.* (1965) indicated that *X. punctatus* is exceptional in habitat, living on coniferous foliage. Jennings and Collins (1987b) summarized the known coniferous-tree habitats of *X. punctatus*, which included species of *Abies*, *Picea*, and *Pinus*. In Minnesota, this crab spider previously had been collected from white spruce, *Picea glauca* (Moench) Voss, (Houseweart and Kulman 1976) and from red pine, *Pinus resinosa* Aiton, (Heimer *et al.* 1984). Aitchison-Benell and Dondale (1990) reported that *X. punctatus* is found on coniferous foliage in Manitoba.

However, in northern regions, *X. punctatus* is not restricted to foliage of conifers; it also has been taken from deciduous trees, such as apple, *Malus pumila* Mill., in Nova Scotia (Dondale 1956), and in Quebec (Bostanian *et al.* 1984, Dondale *et al.* 1979). In Quebec, Belanger and Hutchinson (1992) noted that *X. punctatus* was found in a wooded marsh, near a pond, in forests of poplars and aspen (*Populus tremuloides* Michx.), on a tree and in a curled leaf.

luctuosus Group

Xysticus alboniger Turnbull, Dondale, and Redner, 1965

Identification.—This species is easily recognized and distinguished from all other species of *Xysticus* in North America by the uniformly dark carapace and off-white to gray abdomen. The embolus of the male palpus arises about mid-length of the tegulum on the prolateral side. The atrium of the female epigynum is narrow and elongate (Turnbull *et al.* 1965, Dondale and Redner 1978).

The species was previously known as *Synema bicolor* Keyserling, 1884; however, Turnbull *et al.* (1965) indicated that the name *bicolor* was preoccupied in the genus *Xysticus*, and therefore proposed the new name, *X. alboniger*.

Record.—St. Paul: $n = 1$ collection; 1 male.

Biology.—Not much is known about the biology of this colorful spider. In Ramsey County, a single male was collected in June on a limestone outcrop along the Mississippi River. In North Dakota, Sauer (1972) also collected a single female of this species in June.

Dondale and Redner (1978) reported that specimens of *X. alboniger* have been taken in pitfall traps set in litter of fields, forests, and bogs, and by sweep nets in grasses, shrubs, and trees in Canada.

Other recorded habitats for *X. alboniger* include: in a mown meadow near Belleville, Ontario (Dondale 1971, Dondale *et al.* 1972); in grassland at Itasca State Park, Minnesota (Heimer *et al.* 1984); on balsam fir (*Abies balsamea* (L.) Mill.) foliage in New Brunswick (Loughton *et al.* 1963); and sweeping a meadow dominated by smooth brome in Washington County, Minnesota (B. Cutler, personal observation).

Young and Edwards (1990) included a single record of *Synema bicolor* [= *Xysticus alboniger*] associated with cotton in Alabama.

Faunal Similarities

As expected, faunal similarities with other regions were greater among genera of crab spiders (QS range, 57.1-100.0 percent) than those among species (QS range, 24.2-79.2 percent) of crab spiders for the compared studies (table 1). Most of the QS values for species similarities were greater than 50 percent, which by definition (Price 1975) indicates that the compared faunas are similar. Nonetheless, in four comparisons, QS values for species were less than 50 percent: species of Philodromidae at Lake Itasca, Minnesota (Heimer *et al.* 1984) and in New York (Leonard 1928); species of Thomisidae in Michigan (Drew 1967) and in Ohio (Beatty 1988) (table 1). By definition (Price 1975), these low QS values indicate that the compared faunas are dissimilar. Two of the dissimilarities with the Ramsey County fauna involve island studies in the Great Lakes region.

DISCUSSION

Spider Taxa

The results of this study indicate that Ramsey County, Minnesota has a diverse crab spider fauna comprised of 2 families, 10 genera, and 35 species. The taxa are unequally distributed between families as might be expected: Philodromidae, 3 genera and 13 species; Thomisidae, 7 genera and 22 species. For North America, Dondale and Redner (1978) estimated 5 genera and 102 species of Philodromidae and 9 genera and 121 species of Thomisidae.

Our results in Minnesota are comparable to other faunistic surveys of crab spiders in the Midwest and Great Lakes regions. Without question, the faunistic surveys in the States of Illinois (Moulder 1992), Michigan (Snider 1991), and North Dakota (Sauer 1972), and in the Provinces of Manitoba (Aitchison-Benell and Dondale 1990) and Quebec (Belanger and Hutchinson 1992), are the more comprehensive of the compared studies. This is especially evident for the Philodromidae; where n = 25 species in Michigan, 23 species in Illinois, 22 species in Manitoba, 19 species in North Dakota, and 17 species in Quebec. Likewise, the Thomisidae showed similar abundances of species for these same States and Provinces; where n = 33 species in North Dakota, 31 species in Michigan, 29 species in both Quebec and Manitoba, and 24 species in Illinois. The remaining studies in the Midwest and Great Lakes regions yielded only 3 to 14 species of Philodromidae and 9 to 23 species of Thomisidae.

Faunal Similarities

Despite differences in regions and areas covered, the similarities among the crab spider faunas of the upper Midwest and Great Lakes regions are striking (table 1). Because our survey encompassed only one county (419 km^2), whereas some of the other surveys included entire States and Provinces, we expected that QS values might fall below the 50 percent level, thus indicating dissimilarity of faunas (Price 1975). Nevertheless, dissimilarities (i.e., QS < 50.0 percent, table 1) were detected in only four instances; two involved comparisons of the Ramsey County fauna with that found on islands in the Great Lakes.

We suspect that differences in geography (mainland *vs* islands), vegetation (oak-savanna *vs* beech-maple-mixed conifer forest), microhabitat, and collection method may account for some of the observed dissimilarities in crab spider faunas. Beatty (1988) also concluded that microhabitat diversity is vastly more important to spider species composition than size of land area, i.e., island size.

Previous Records of Philodromidae and Thomisidae in Ramsey County

Apparently, there are no published records of Philodromidae having been collected in Ramsey County, Minnesota, before our study. However, several philodromid species have

Table 1.—*A comparison of the crab spider fauna found in Ramsey County, Minnesota, with similar faunas in the Upper Midwest and Great Lakes regions. (QS = Sørensen's Similarity Quotient X 100.)*

Location of compared study	QS value by spider taxon			
	Philodromidae		Thomisidae	
	Genera	Species	Genera	Species
ILLINOIS				
Moulder (1992)	85.7	55.6	93.3	65.2
MANITOBA				
Aitchison-Benell & Dondale (1990)	85.7	68.6	92.3	51.0
MICHIGAN				
Chickering (1940)	85.7	59.3	100.0	61.5
MICHIGAN				
Drew (1967)	85.7	69.6	72.7	45.2
MICHIGAN				
Snider (1991)	85.7	68.4	100.0	79.2
MICHIGAN-ILLINOIS-INDIANA				
Lowrie (1948)	85.7	56.0	92.3	55.6
MINNESOTA				
Heimer *et al.* (1984)	80.0	25.0	92.3	50.0
NEW YORK				
Leonard (1928)	57.1	44.4	100.0	68.2
NORTH DAKOTA				
Sauer (1972)	85.7	70.9	92.3	61.8
OHIO				
Beatty (1988)	66.7	52.2	76.9	24.2
QUEBEC				
Belanger & Hutchinson (1992)	100.0	66.7	76.9	58.8
WISCONSIN				
Levi & Field (1954) Levi *et al.* (1958)	85.7	61.5	100.0	62.2

distributional ranges that encompass Minnesota (Dondale and Redner 1975a, 1978; Gertsch 1933) and probably include Ramsey County. Previously published records of Thomisidae from Ramsey County, Minnesota, include only three species: *Misumena calycina* (Linneaus, 1758) [= *M. vatia* (Clerck, 1757)], *Ozyptila americana* Banks, 1895, and *Xysticus triguttatus* Keyserling, 1880; all were recorded by Gertsch (1939).

Species Likely to Occur in Ramsey County

Numerous species of Philodromidae and Thomisidae were not collected in this study, but they are likely to occur in Ramsey County, or in Minnesota. These include species which are known from other counties in Minnesota (Gertsch 1939, 1953; Cutler *et al.* 1975; Heimer *et al.* 1984). Obviously, species collected in nearby counties of Minnesota are most likely to occur in Ramsey County; those from distant counties are less likely to be found. The species and their published records in Minnesota are listed below; the listings follow that of Dondale and Redner (1978) for the Philodromidae, and Turnbull *et al.* (1965) for the Thomisidae. Recent synonymies of taxa are taken into account.

PHILODROMIDAE

Ebo pepinensis Gertsch, 1933. Type locality Wacouta Beach, Lake Pepin, Wabasha County, Minnesota (Gertsch 1933). Also recorded from Stillwater, Washington County, Minnesota (Sauer and Platnick 1972).

Philodromus alascensis Keyserling, 1884. Recorded from Minneapolis, Hennepin County, Minnesota (Dondale and Redner 1975a).

Philodromus marxi Keyserling, 1884. Recorded from Whitewater State Park, near Elba, Winona County, and from Minneiska, Wabasha County, Minnesota (Dondale and Redner 1968).

Philodromus exilis Banks, 1892. Recorded from Lake Itasca State Park, (Clearwater and Hubbard Counties), Minnesota (Dondale and Redner 1968, Heimer *et al.* 1984).

Philodromus minutus Banks, 1892. Recorded from Minneapolis, Hennepin County, and from Helmer Myre State Park, Freeborn County, Minnesota (Dondale and Redner 1968).

THOMISIDAE

Coriarachne versicolor Keyserling, 1880. Recorded from Minneapolis, Hennepin County, and from Stillwater, Washington County, Minnesota (Gertsch 1939).

Coriarachne utahensis Gertsch, 1932. Recorded from Minneapolis, Hennepin County, Minnesota (Gertsch 1939).

Ozyptila georgiana Keyserling, 1880. Recorded from Minneapolis, Hennepin County, and from Clay County, Minnesota (Dondale and Redner 1975b).

Ozyptila monroensis Keyserling, 1884. Recorded from Minneapolis, Hennepin County, Minnesota (Gertsch 1939).

Ozyptila sincera canadensis Dondale & Redner, 1975. Recorded from Minneapolis, Hennepin County (Gertsch 1939, 1953); from Itasca State Park, (Clearwater and Hubbard Counties) (Dondale and Redner 1975b); and from Lake of the Woods and Koochiching Counties, Minnesota (Cutler *et al.* 1975).

Ozyptila curvata Dondale & Redner, 1975. Recorded from Otter Tail County, Minnesota (Dondale and Redner 1975b).

Xysticus fraternus Banks, 1895. Recorded from Lake Minnetonka, Hennepin County, Minnesota (Gertsch 1939).

Xysticus luctuosus (Blackwall, 1836). Recorded from Itasca State Park, (Clearwater and Hubbard Counties) (Gertsch 1939), and from Lake of the Woods and Koochiching Counties, Minnesota (Cutler *et al.* 1975).

Xysticus ellipticus Turnbull, Dondale, & Redner, 1965. Recorded from Lake of the Woods and/or Koochiching County, Minnesota (Cutler *et al.* 1975).

No doubt, more intensive and extensive collecting with the same methods we used (sweeping, beating, hand-collecting, pitfall traps), and employment of other sampling-collecting methods (Berlese and Tullgren funnels, litter sorters, etc.) will yield additional specimens of species collected during this study, and specimens of species likely to occur in Ramsey County. For example, *Philodromus exilis* and *P. mysticus* are both common inhabitants of coniferous foliage; additional beating collections from conifers should yield specimens of these species. Likewise, many species of *Xysticus* and *Ozyptila* are commonly found on the ground and amongst litter; pitfall traps and litter samples should yield additional species not recorded in this study.

Conversely, many philodromid and thomisid species not found during this study may be absent from Ramsey County due to the alteration, destruction, or loss of habitats resulting from urban-suburban sprawl. Such perturbations are critically important to spider species that have specific habitat requirements, e.g., species associated with or restricted to prairies or remnants of prairies. No doubt rarely collected species, e.g., *Philodromus keyserlingi*, *Xysticus ampullatus*, *X. chippewa*, and *X. obscurus*, will become even less abundant as old field-mixed meadow habitats are converted to shopping malls, condominiums, and parking lots. We also predict that additional species will become synanthropes and anthropochores (Kaston 1983, Cutler 1973) as natural habitats are replaced by buildings and other human-made structures.

Our study provides a historical perspective of the crab spider fauna present in Ramsey County during the period 1965 to 1995. Such historic perspectives are needed for future assessments of the fauna and possible changes in the fauna brought about by regional and global perturbations.

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1996. **Crab spiders (Araneae: Philodromidae, Thomisdae) of Ramsey County, Minnesota**. Gen. Tech. Rep. NC-185. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment ion. 35 p.

Crab spiders of 2 families, 10 genera, and 35 species were collected over a 31-year period in Ramsey County, Minnesota. Rarely collected species included *Philodromus keyserlingi, Xysticus pellax, X. chippewa, X. banksi* and *X. alboniger.* Identification source(s), season and collection frequency, and biology are summarized for each species.

KEY WORDS: Spiders, Araneae, faunal survey, Minnesota, faunal similarities.

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Our job at the North Central Forest Experiment Station is discovering and creating new knowledge and technology in the field of natural resources and conveying this information to the people who can use it. As a new generation of forests emerges in our region, managers are confronted with two unique challenges: (1) Dealing with the great diversity in composition, quality, and ownership of the forests, and (2) Reconciling the conflicting demands of the people who use them. Helping the forest manager meet these challenges while protecting the environment is what research at North Central is all about.